METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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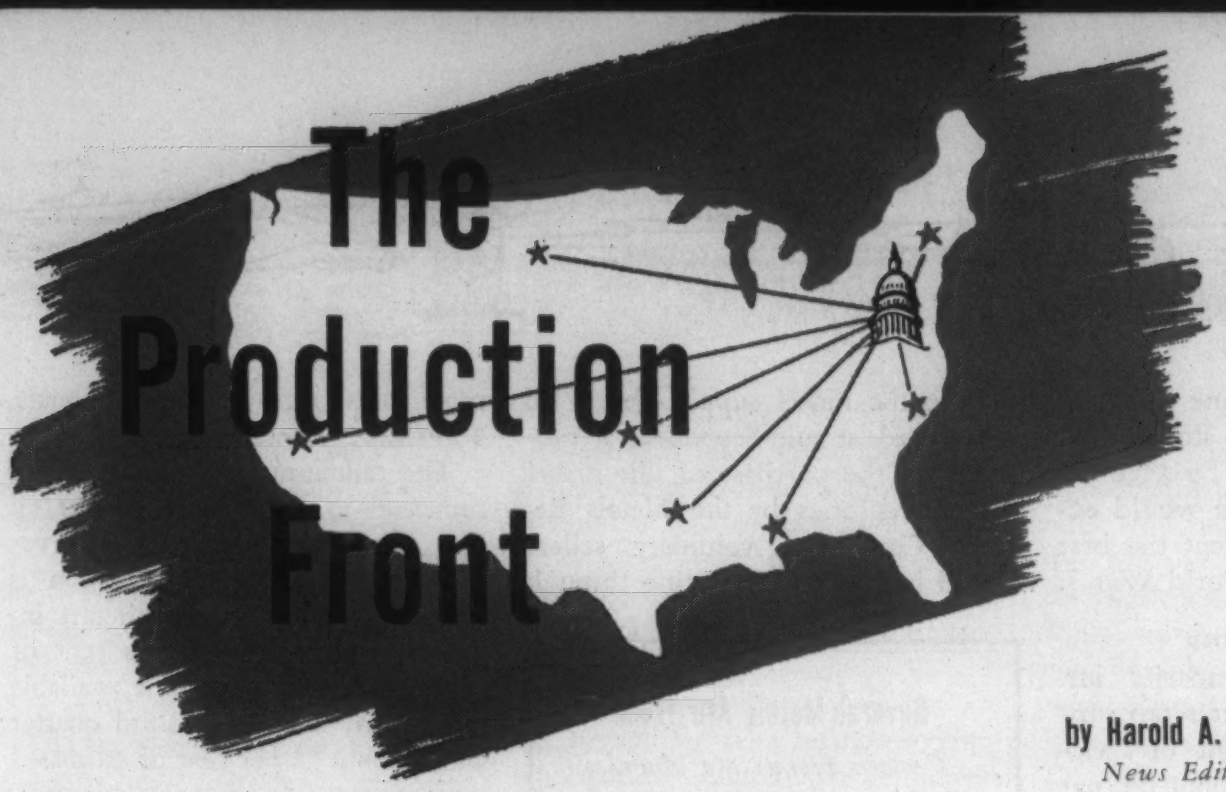


by Harold A. Knight
News Editor

Green lights on steel output result in sodium lights of mellow satisfaction. . . . New high output records in steel and pig iron for U. S. and leading companies. . . . Surplus steel ingots go traveling. . . . Please, sir, use electric furnace alloy steel to save carbon steel.

The more of the enemy's equipment we capture or destroy, the less we need to produce. . . . We are still far behind our steel capacity goal. . . . "Victory scrap banks" campaign started. . . . About 500,000 tons of battle-scrap yearly. . . . Idle nickel salts requested.

Cadmium supply insufficient. . . . Calcium more relaxed. . . . Wood will save 5,000,000 tons of steel in 1943. . . . Interesting time studies in brass mills and factory-to-battlefield. . . . Our poet and cartoonist sings of micrometers. . . . It's the style to paint the post-war auto. . . . Is an editor a mouse or a man? . . . Odds and ends about production. . . . Hush-hush weapons rapidly become public.

Steel Output Good — Yet Far From Goal

Green lights for additional steel-making capacity, turned on a few months ago, are beginning to change to sodium lights of mellow satisfaction as we see new production records made. The green lights had signified that components which might be used in several undertakings be diverted solely to construction of open-hearth and electric steel furnaces.

The steel pace for the week, starting with September 20, was scheduled to be 100.6 per cent of capacity. Though this may not be a new high for the war from a percentage standpoint, it is an all-time top as to tonnage. Thus, the 1,753,400 tons of steel ingots scheduled for the week compares with 1,645,700 tons a year ago.

Several companies have been making new records. Carnegie-Illinois, the world's largest steel maker, made one in August, turning out 1,962,631 net tons, or 19,000 tons above the best previous month in March.

Inland Steel Co. announces that five blast furnaces at Indiana Harbor have maintained uninterrupted production for more than three years in what is believed to be a group continuous operational record. Normally, linings wear out too fast to allow such long production.

Some Steel Ingot Surplus

What might have seemed embarrassing at first blush is that some of the new open-hearth furnaces have been placed in operation before the rolling mills, designed to handle the ingots, were completed. However, this problem has been mostly solved, according to H. G. Batcheller, Operations Vice Chairman, W.P.B.

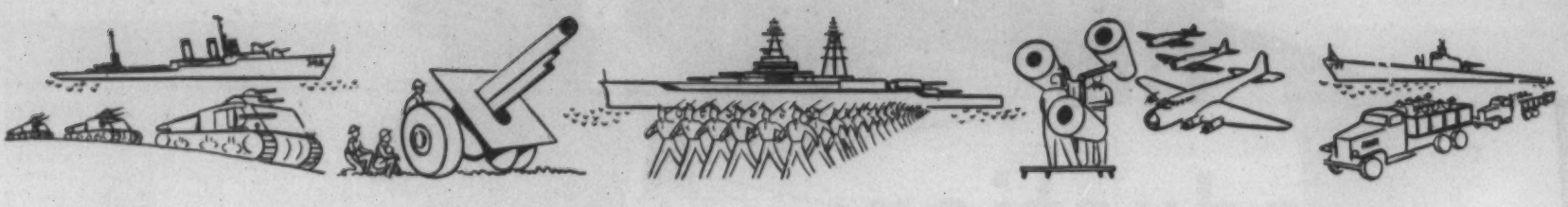
Thus, ingots from the Kaiser plant in California have been shipped to our Allies under Lend-Lease. Ingots produced by Carnegie-Illinois at Homestead, Pa., have been used by other U. S. Steel Corp. plants or by similar steel companies, such as Bethlehem at Johnstown, Pa., where there was excess finishing capacity.

There are other forms of juggling in the steel industry to keep good balance. Thus, on Sept. third, steel buyers were being urged to use electric furnace alloy steel instead of the open-hearth variety to release the latter for the manufacture of carbon steel, for which requirements are far in excess of supply — surely an Alice-in-Wonderland state of affairs! (Like a cartoon in the original *Life* magazine: "Hurry up, Johnny, eat your ice cream and then you can have your lovely spinach!")

Equivalent of Steel Production

Then, there is an indirect form of steel production of which we must take cognizance. At mid-September 80 surrendered vessels of the Italian Navy sailed to Malta. Again, in 50 recent aerial engagements, Curtiss (P-40) fighters have taken a toll of the enemy at a 13½-to-1 ratio, according to a "box score" kept by Curtiss-Wright Corp. And so could such illustrations be multiplied.

As good as our steel production has been, we are quite far behind goals. Capacity as of last July 1 was to have been 96,000,000 tons of ingots yearly, but it will not be attained until well into 1944. Steelmakers state that until recently they were not given high enough priorities for plant equipment, playing sec-



ond fiddle to high-octane gas and synthetic rubber. Actual steel output in 1943 will probably be 90,000,000 tons. That tonnage would exceed by nearly 80 per cent the best annual production in World War I.

Again Time to "Get in the Scrap"

Larger steelmaking capacity implies the need for greater scrap supplies. The establishment of "victory scrap banks" throughout the nation was announced by Donald M. Nelson on September 15, the drive to extend from October 1 to November 15.

The newspapers, which collected 6,000,000 tons in last year's campaign, are expected to function again.

At mid-September consuming steel mills and suppliers had on hand 7,500,000 tons, enough for only two months.

It is also pointed out that difficulties in shipping ore may reduce actualities from the goal of 95,000,000 tons for the season to 86,500,000 tons. Coal strikes cost around 300,000 tons of pig iron, necessitating compensating scrap.

Yet, battlescrap should play an increasing role. Receipts this year should reach 500,000 tons, according to Edwin C. Barringer, president, Institute of Scrap Iron & Steel. Most of it is going to Eastern mills, but not to Chicago, an area where shortages may first be felt keenly. Most of our Mediterranean scrap is now processed in North Africa. There is talk that Italy will become the headquarters. Cutting, sorting and otherwise preparing the scrap is best done before shipment for sake of economical use of shipping space and ease of handling, it is conceded.

In our September issue we warned of the danger sometimes involved in using battlescrap, because of possible hidden explosives. We learn that by now letters have been sent to all scrap dealers, and perhaps scrap consumers, telling of these dangers without unduly alarming those concerned.

The Non-Ferrous Situation

It is still necessary to conserve most of the non-ferrous metals. To add to the nickel supply, the WPB announced at mid-September a program for the purchase of idle nickel salts inventories by the Metals Reserve Co. The voluntary sellers would be the platers, acting through the International Nickel Co. as agent.

The following are the minimum quantities purchasable and prices per lb.: Nickel sulphate, 300 lbs. or more, 11.5 cents; nickel ammonium sulphate, 300 lbs. or more, 10.0 cents; nickel chloride, 100 lbs. or more, 14.0 cents; nickel carbonate, 100 lbs., 27.5 cents.

The cadmium supply will not be sufficient to meet requirements, it was announced, following a survey in early August. The situation is especially critical in the aircraft industry, which uses 50 per cent of the supply. The amount available for aircraft during the third quarter will be only 75 per cent of estimated requirements.

Army Air Forces and the Bureau of Aeronautics are studying end-use classifications, and will prepare lists identifying parts on which cadmium plating is deemed essential. Meanwhile, all consumers are asked to screen out all non-essential uses and substitute zinc.

However, the situation is better concerning calcium, with supply and demand well balanced. The allocation order which has controlled the distribution of calcium since April 1 was rescinded at mid-August.

Scarce Today; Plentiful Tomorrow

Substitutions are ever fluctuating and will doubtless continue to do so until the war's end. The use of wood will save 5,000,000 tons of metal in 1943, states Joseph L. Stearns, National Lumber Manufacturers' Association.

American combat units are being supplied with a shorter, lighter and sturdier bayonet, saving 362 tons of high-carbon steel in 1943 and 500 tons in 1944. The blade has been shortened 6 in., may be used as a trench knife, is easy to handle, and is especially welcomed by jungle fighters, paratroops and air-borne infantry.

Wooden cargo airplanes, G-76, designed for medium range with a cargo capacity of 4,500 lbs., are to be abandoned because there is a shortage of wood and an abundance of aluminum.

Several Metals Are Freer

Certain metals are abundant or scarce, depending on who is talking, as we have said before. From interviews with several metal-production and sales executives, who completely sold us by the genuine ring of their statements, we have learned:

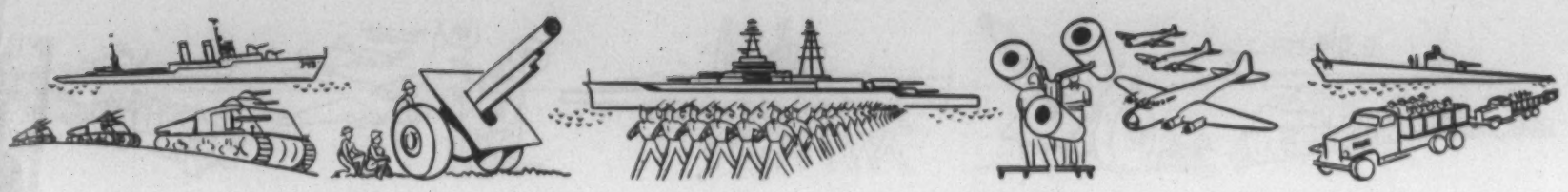
Tungsten, which two years ago was exceedingly critical, is highly plentiful and the Government is stockpiling it. 18-4-1 steel may soon come back into general use. Cobalt and vanadium are both being stockpiled and are abundant. Molybdenum should be abundant again by early 1944. Nickel is sufficient for war production, and output has not suffered despite the mining manpower shortage in Canada.

Magnesium is extremely plentiful as an ingot metal, but lacks fabricating facilities and skilled labor. (There are disputes sometimes as to whether it is structurally sound, but an expert says forgings and extrusions are, though sections thinner than 1/8 in. are subject to corrosion.)

Copper is more abundant, but will not be a drug on the market in war time. Surpluses will mean more brass and less steel cartridge and shell cases.

Time Schedules of War Goods

Very little of our war equipment has time to rust between plant and battlefield. A time check of the travels of a battery of anti-aircraft



artillery will give a typical example. On its route across the country by rail and over the ocean, the shipment went through temperature ranges from minus 10 deg. to 110 deg. Total elapsed time from leaving the manufacturer until the first shell was fired on the enemy was 23 days, 4 hrs. and 20 min.

The shipment covered a battery of anti-aircraft artillery, complete with vehicles, spare parts, cleaning equipment, fire control directors with their multiplicity of watch-like mechanisms and 16,000 component parts, telescopes and range finders with precision glass parts, and ammunition with fuzes that can be adjusted to a fraction of a second. It was ready for instant service on arrival in the combat zone.

And speaking of elapsed times, a "Flow of Typical Aircraft Brass Mill Orders" has been prepared in chart form by the Non-Ferrous Metals Subunit, Materials Distribution Branch, R.C.S., Wright Field, Dayton, Ohio. Primary operations for sheets, wire and pipes require 14 days for getting into suitable semi-finished standard forms.

For secondary operations the time varies, depending on product specified and its number of treatments, from 12 days for solid wire, AWG No. 26 and larger, to 38 days for tubes, 1/64 in. to 3/16 in. The possible processes in these secondary operations are: Heat-treating, cleaning, re-rolling, die making, redrawing, machining, straightening, cut to size, laboratory tests, hydro and pneumatic tests, inspection and packing.

Total days in the mill vary from 26 to 52. In all cases 10 days are added for paper work and 7 days for procuring raw material. Hence, the time between placing of the order and shipment of the product ranges from 43 days to 69 days.

We Survey Post-War Automobile

When a radically different automobile is produced in post-war, it will be by some new and unknown company. Perhaps another Walter P. Chrysler will leave General Motors, or some other old-line manufacturer, to build a rear-engine, light metal, radically-designed car. The well-established makers will largely stick to their old lasts — at least for many months.

This and opinions to follow are the prevailing ones gathered from representative automotive engineers by METALS AND ALLOYS. Those engineers who think in terms of price per unit of structural strength expect large increases over pre-war in use of aluminum. All agree that pistons and other heat-dissipating parts will be of aluminum despite price. Few are impressed by the "all aluminum" advocates. Some expect considerable use of aluminum-magnesium alloys, because of the rich manufacturing experience gained in present aircraft production.

Likeliest conversion from war to peace, with little if any modification, is the jeep. Existing suppliers, tools and production lines could be used in their present set-ups very readily.

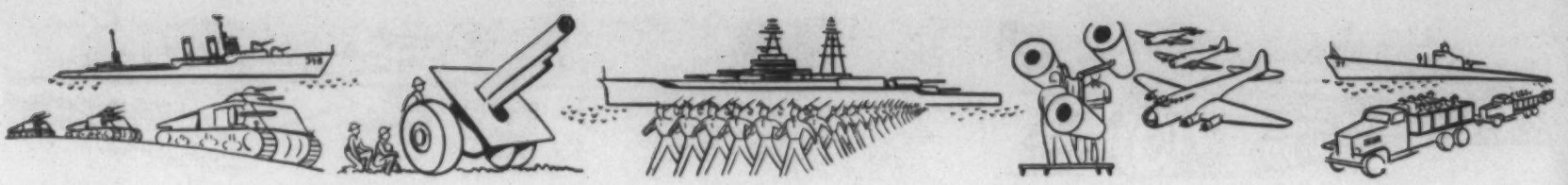
To get back to pleasure cars, design, major components and materials will be about the same as in the pre-war car, the vast majority of sales-conscious engineers believe. Tires are expected to be made of considerable synthetic rubber at first, with natural rubber used mostly in inner tubes and sidewalls of casings. Of course, final costs and relative serviceability will govern if and where synthetic or natural rubber will be used. Recognition and development of rayon cord has leaped forward in a year to the extent that would normally have required a decade.

Old line manufacturers will remain conservative, for they have suffered too many painful experiences in the past with irritating "bugs" that developed after cars were on the market. Not only manufacturers, but a large chain of dealers depend on cars that satisfy the public, both from the start and throughout their life.

Micrometer "Is Mightier Than the Sword"

by V. M. McConnell

Back of the boys on the battle hops,
Where the tanks and the bombers strike,
Is the work back home in the Metal Shops
And a big hard fist with a "mike."
For the Yankee tolerance rules are high
And the Yankee parts run true,
Which is just one more of the reasons why
We can lick this Axis crew.



Editors in the Scheme of Things

During his bilious moments an editor occasionally wonders if he is a useful unit in the scheme of things. Is he a mouse, man or parasite, he sometimes asks himself — particularly during a war? Does he merely write about people who do things and describe the things they do? Is ye editor just a dodderer, not a doer?

Yet the present administration apparently thinks highly of the business and technical editor. No ruling group in Washington has made such a fetish of publicity as the present one. They know that most editors try to influence opinion in the right way; give much-needed information on rulings and regulations, condensing and interpreting them; spread the knowledge and technique of making munitions; present information to give the correct balance and relationship.

We have seen evidences of such esteem in the regular meetings at Washington, where big-wigs from President Roosevelt down take their hair down ("No quotes, please"), and try to tell us what it is all about. They say we ask spirited and intelligent questions. They add that we are earnest listeners to what they say. Then, we go home and tell our readers. No people are better informed than we Americans!

We are always proud when we can do little services towards the war effort. The Board of Economic Warfare, for instance, wanted to know to what war use we could put gold. We asked our readers. The Navy wanted a scrap steel expert; we published the request in a special box. Probably the most novel request was: "Do you have any photographs of German industrial plants — probably prewar?" Targets for bombing, eh what?

Some By-Products of Production

The Government will own about 10 per cent of the total steel capacity of the country after the war, about 92 per cent of the magnesium capacity, and more than 50 per cent of the aluminum production capacity, states Jesse Jones.

More than four-fifths of the net addition of 1,833,000 to the working forces in American factories from April, 1942 to last June have been women. Over 6,000,000 more women are employed today than in July, 1940. A total of 17,100,000 women are now at work.

A list of names of industrial plants in Germany and Japan that manufacture products similar to those of Manning, Maxwell & Moore Co., Bridgeport, Conn., was secured by the Manning management. A short recording was then made of a Jap or German commentator speaking in a most belligerent tone. This was followed on the recording by an interpreter, stating that the speaker was a worker in a particular factory in Yokahoma or Cologne, and shouting that he was personally prepared to outproduce any American worker in the Manning plant. This morale-building stunt is aimed to bring home the fact that it is a war in the plant also.

The most extensive exploratory program ever undertaken in the United States and Alaska for war minerals has been launched under a $3,900,000 Congressional Appropriation. They will examine industrial diamond areas of Arkansas, explore coal fields of Nevada and Oregon, and search generally for quartz crystals, copper, asbestos, zinc, mercury, tungsten, vanadium, beryllium, corundum, molybdenum, manganese, tin, iron, chromium, bismuth and nickel — with emphasis on copper and zinc because of scarcity.

Whereas it took 88 years to bring the Springfield rifle to its present high state of perfection and 20 years to develop the Garand, the carbine went immediately into production from its first official test in 1942. Having 63 parts, it is nearly 4 lbs. lighter than the other two guns, and its cartridges weigh only half as much as standard ammunition. Whereas the Garand is made for the expert rifleman, the carbine is the weapon for every soldier. It has a minimum of muzzle flash, hence valuable for night fighting. It is descended from the famous old lever-action carbine that won the West. Gas from the exploded cartridge both ejects that particular cartridge and loads the next.

Hush-Hush Is Ever Short-Lived

An Army officer told us the other night that the "war weapons being made today were planned on yesterday's battlefield."

Bombers soon to go into action will dwarf the present Flying Fortresses, and will carry half a carload of bombs across the Atlantic and fly home without a stop, states General H. H. Arnold, commanding officer of the U. S. Army Air Forces. They are now being built in a plant of the Wright Aeronautical Corp., and will be powered by Wright Cyclone-18 engines. More details are not revealed as yet.

However, we are impressed by the rapidity with which details concerning a new weapon are made public. Six months ago there was much hush-hush about the "bazooka," but gradually details leaked out, such as that it was a glorified pipe, that it could be handled by two infantrymen, and that it fired on the rocket principle. Finally, photographs began to appear in the press, and an exhibition was given at the Army show on the Washington Monument grounds in September, at which time precise details were supplied.

Two months ago we heard that General Sherman tanks could fire on the run, whereas previously tanks had to stop. Now it is revealed that a gyroscope keeps the gun trained on the target.

In only one instance have we heard where details about equipment were becoming public too fast. That was Radar. Too many manufacturers were getting ever bolder in revealing facts about its mechanism in their advertisements, and we understand the order went out for these manufacturers to cease.

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Tools that Open the Door to Increased Output per Machine

In most plants, machine and press speeds are continually checked. But still another way to get more output is to *make a study of machine shutdown time.*

And your tool room is the place to *start* the job of eliminating idle machine time. For the common causes of production delays—repairing, regrinding and replacing tools that fail prematurely—can often be traced directly to improper selection and heat treatment of the tool steels used.

In thousands of plants, Carpenter is helping to get at the causes of these delays. Through the Carpenter Matched Set Method of selecting tool steel, a definite *system* is provided for picking the *one* tool steel that will do each job best. Typical examples of the results of using this method are shown on the opposite page.

But Carpenter's aid to tool steel users includes more than help in the selection of the proper tool steel for each job. For example, the Tool Steel Manual shown below can be used to insure correct heat treatment of each tool. And "Tool Steel Simplified" contains page after page of useful trouble-shooting information. Send for any of this material you may need . . . and remember that your nearby Carpenter representative is ready to give you the benefit of his diversified experience with tool steel problems. Call on him whenever the need arises.

Put These 3 Tool Room "Assistants" to Work on Your Problems!

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FREE

Spark Testing is useful in segregating tool steel scrap, identifying mixed stocks and checking the identity of the steel before tools are heat treated. And this 21" x 32" wall chart contains all of the basic information you need to train men to quickly identify different types of tool steel. It gives information on spark characteristics caused by major alloys, grinding wheel speeds, etc. Send for your free copy today.

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Introduction

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George Nelidoff Photo

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The National Metal Congress for 1943 will be similar to the one held last year in Cleveland. The main difference is that there will be no extensive exposition as in all the previous 25 years' history of this annual event. The Congress will be held this year in Chicago, Oct. 18 to 22, with the main headquarters at the Palmer House. As in Cleveland last year, the afternoons will be devoted to special sessions relating to the war effort.

The Participating Societies

As in the past there are four technical societies participating in this Congress: The American Society for Metals, sponsor of the entire congress; the two metals divisions of the American Institute of Mining and Metallurgical Engineers; the American Welding Society; and the Wire Association.

Leading men in these four societies have prepared the usual assortment of technical papers, lectures and discussions which cover nearly every phase of the metal industries.

The afternoons will be devoted to the War Production Sessions, the theme of which will be "increased production of war products, conservation of materials, and post-war conditions." Prominent men in industry and official life will address these sessions for which a special program has been prepared.

No Exposition

For the first time in the history of these annual events, there will be no large scale exposition. Instead, the rooms of three entire floors of the Palmer House will be devoted exclusively to conference purposes, limited to displays of light equipment, diagrams, charts, literature, etc. The prospects are bright for a broad participation in this undertaking.

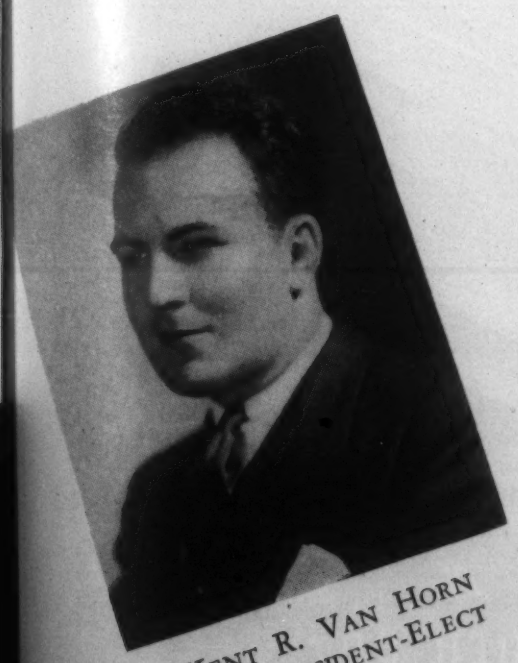
Lectures

The Campbell Memorial Lecture is always the feature technical event of the Congress. This year it will be delivered by C. H. Mathewson, professor of metallurgy, Yale University.

The series of educational lectures, which have been a feature of recent congresses, are not scheduled in this year's tentative program.

In General

The participating societies hold their technical sessions at each of the respective hotels which constitute their headquarters. On other pages will be found the tentative technical programs of each society.



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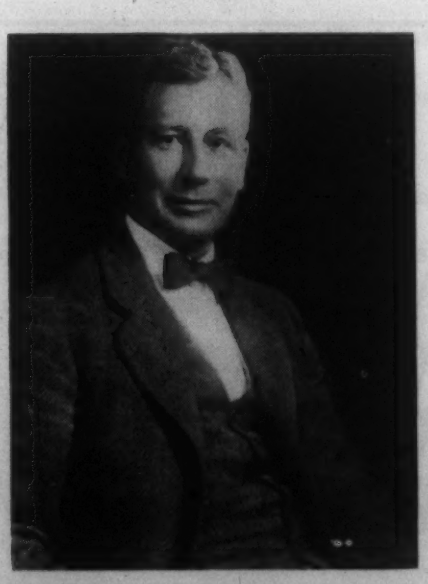

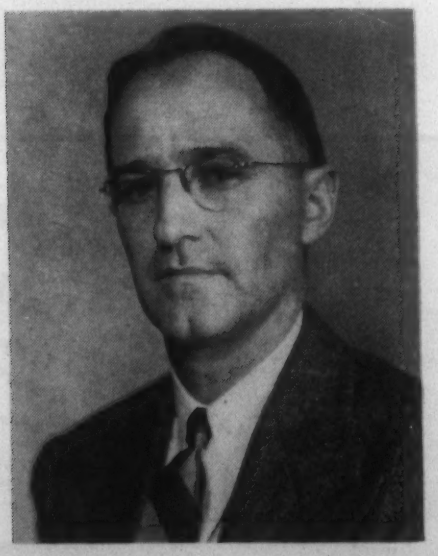

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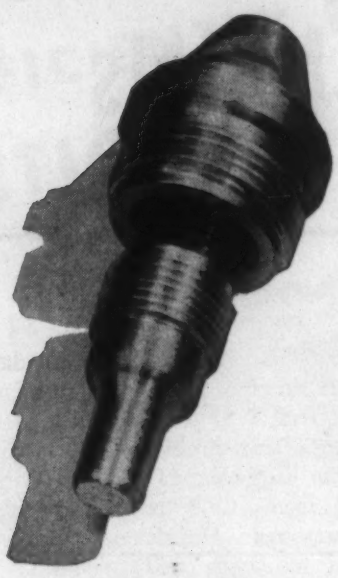

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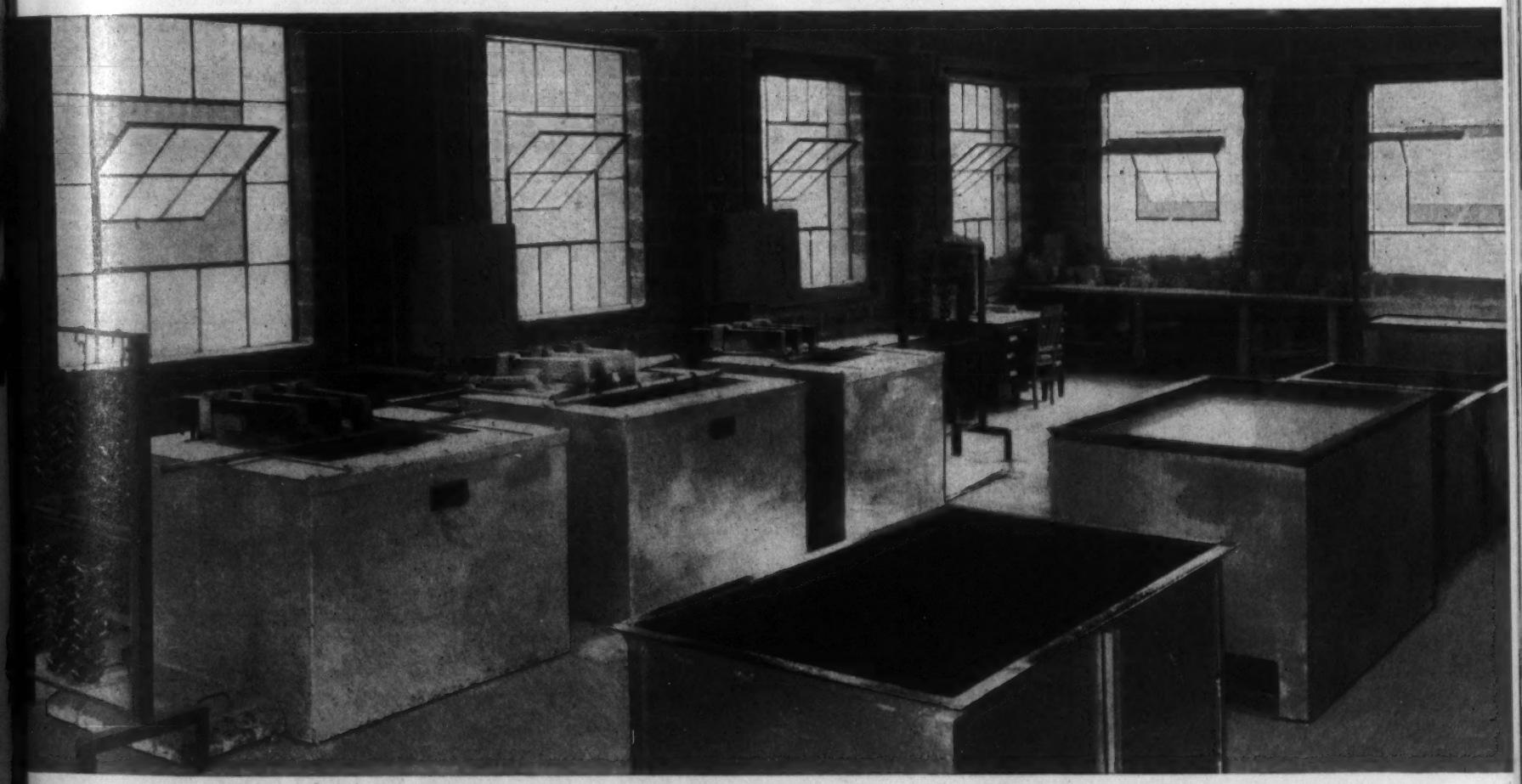

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Tentative Technical Program of the

American Society for Metals

Nearly 40 papers are scheduled for this year's technical program of the American Society for Metals, always regarded as one of the chief technical features of the Congress. The program corresponds quite closely in number of papers and scope to the program a year ago.

All of the sessions, three simultaneous ones, will be held during the morning of each day at the society's headquarters, the Palmer House, similar to the plan a year ago. The afternoons are devoted entirely to the War Production Sessions which are patterned after the Increased Production Sessions at the Cleveland Congress in 1942.

These special war sessions are to be participated in by leading Government officials and industrialists, as well as by prominent metallurgical engineers. Special practical subjects, having to do with increased production and conservation, will be discussed off the record. Judged by the results of the sessions a year ago, those this year will be equally profitable.

As in some previous congresses, there will be so-called "inspirational sessions" at 11:30 a.m. each day. They will be addressed as in the past by prominent persons in the Army, Navy and War Production Board. Complete coverage of important problems has been arranged and the final program is predicted to be a composite of suggestions received from 1200 prominent members of the Society. The same type of informal discussion, characteristic of previous meetings, will prevail.

The technical highlight of the Congress — the Campbell Memorial Lecture — will be delivered Wednesday morning Oct. 20, in the ballroom of the Palmer House, by C. H. Mathewson, professor of metallurgy, Yale University. Dr. Mathewson is also president of the American Institute of Mining and Metallurgical Engineers. This lecture is preceded by the annual meeting of the A.S.M.

The annual banquet will probably be held at the Palmer House the evening of Thursday, Oct. 21, but definite plans had not been announced as we go to press. (All banquets may be dispensed with.) It is customary to present annual awards at this function.

The tentative technical program for the A.S.M. sessions is as follows:

MONDAY MORNING, OCT. 18

"Quenching and Hardenability of Hollow Cylinders," by J. H. Hollomon and C. Zener, Watertown Arsenal.

"Rates of Cooling in Blocks and Cylinders," by C. B. Post and W. H. Fenstermacher, Carpenter Steel Co.

"An Evaluation of Quenching Oils," by E. K. Spring, P. T. Lansdale and C. W. Alexander, Henry Disston & Sons, Inc.

Simultaneous Session

"An X-Ray Study of Brasses Formed by the Interdiffusion of Copper and Zinc Deposited on Glass by Vaporization," by A. A. Burr, Armstrong Cork Co.; H. S. Coleman, H. L. Yeagley and W. P. Davey, Pennsylvania State College.

"Dimensional Changes Encountered in Tube Sinking," by W. M. Baldwin, Jr. and T. S. Howald, Chase Brass & Copper Co.

"A Metallographic Study of the Decomposition of Austenite in Manganese Steels," by John V. Russell, Republic Steel Corp., and Francis T. McGuire, University of Kentucky.

Simultaneous Session

"The Microhardness Tester as a Metallurgical Tool," by Constance B. Brodie, General Electric Co.

"Intercrystalline Cohesion of Metals," by E. R. Parker, General Electric Co.

"Plastic Flow and Rupture of Metals," by C. Zener and J. H. Hollomon, Watertown Arsenal.

TUESDAY MORNING, OCT. 19

"The Effect of Varying Amounts of Martensite Upon the Isothermal Transformation of Austenite Remaining After Controlled Quenching," by H. J. Elmendorf, American Steel & Wire Co.

"Martensite Reactions in Alloy Steels," by Peter Payson and Charles H. Savage, Crucible Steel Company of America.

"Influence of Nickel, Molybdenum, Cobalt and Silicon on the Kinetics and Ar" Temperature of the Austenite to Martensite Transformation in Steels," by H. H. Chiswick, Battelle Memorial Institute, and A. B. Greninger, University of Chicago.

Simultaneous Session

"High Speed Testing of Mild Steel," by J. H. Hollomon and C. Zener, Watertown Arsenal.

"The Effect of Heat Treatment and Carbon Content on the Work Hardening Characteristics of Several Steels," by John H. Hollomon, Watertown Arsenal.

"The Tensile Properties of Alloyed Ferrites," by C. E. Lacy, International Nickel Co., and M. Gensamer, Carnegie Institute of Technology.

Simultaneous Session

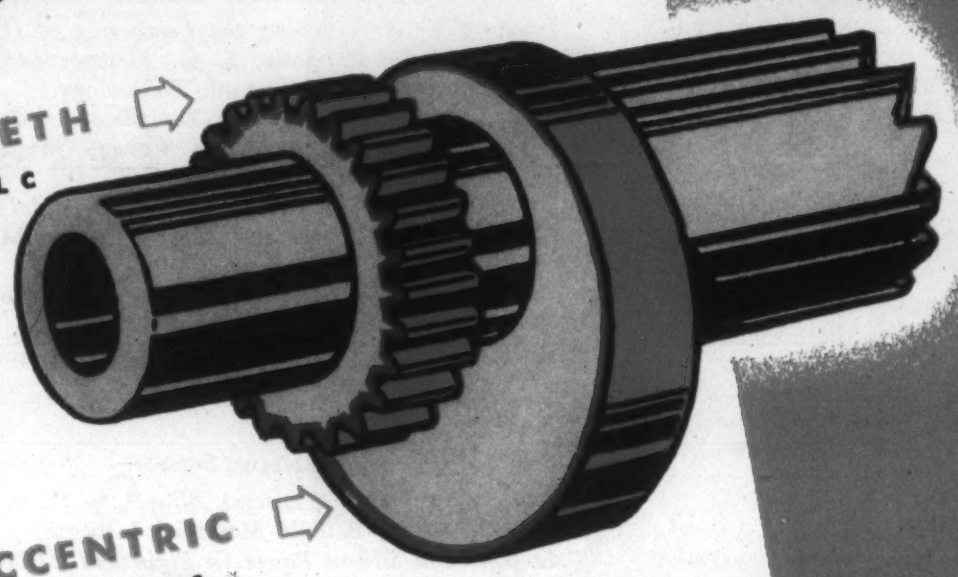
"A Study of the Nitriding Process—I. Effect of Ammonia Dissociation on Case Depth and Structure," by Carl F. Floe, The Nitralloy Corp.

"The Action of Carbonate Catalysts in the Carburization of Steel," by T. C. Fong and R. A. Ragatz, University of Wisconsin.

"The Isothermal Transformation of Case-Carburized S.A.E. 4815," by J. R. Cruciger and J. R. Vilella, United States Steel Corp.

(Continued on page 704)

HARDENING
AND EFFICIENTLY PERFORMED WITH INDUCTION HEATING . . . .



● Since Van Normanizing permits users to heat a specific portion of metal to a predetermined depth, hardening different parts to various degrees of hardness on the same piece is easily and quickly accomplished with Van Norman High Frequency Induction Heating. In the illustration, three different surface hardening operations are performed. Gear teeth are hardened to 54 Rockwell C in 16 seconds; eccentric to 62 Rockwell C in 22 seconds; clutch teeth to 57 Rockwell C in 13 seconds. There is no warping or distortion, and the finished part is free from undesirable scale. And because the entire heat and quench cycle is automatic, finished parts are identical in hardness and physical characteristics.

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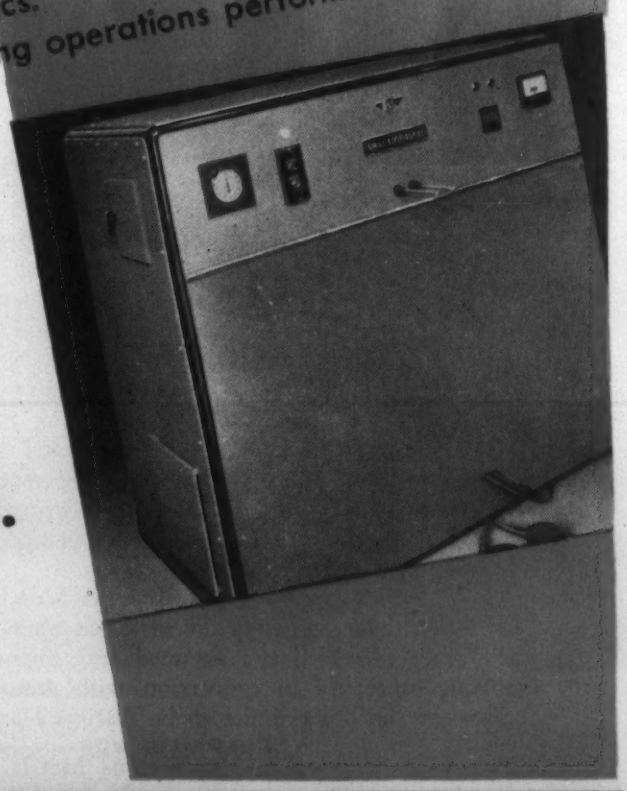

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A.S.M. Program—*Continued from page 700*

WEDNESDAY MORNING, OCT. 20

ANNUAL MEETING OF AMERICAN SOCIETY FOR METALS

The 1943 *Edward de Mille Campbell Memorial Lecture,* by C. H. Mathewson, Professor of Metallurgy, Yale University.

THURSDAY MORNING, OCT. 21

"Order Hardening: Its Mechanism and Recognition," by David Harker, General Electric Co.

"Interrupted Quench and Isothermal Treatments of Precipitation Hardening Alloys: Introductory Notes," by R. H. Harrington, General Electric Co.

"An X-Ray Study of the Time-Rate of Precipitation From a Solid Solution of Copper in Aluminum," by Charles H. Townes, Virginia State College.

SIMULTANEOUS SESSION

"Bright Gas Quenching of S.A.E. X-4130 Welded Aircraft Tubes," by Wm. Lehrer, Surface Combustion.

"Some Effects of Heat Treatment on Low Alloy Titanium Steels," by George F. Comstock, Titanium Alloy Manufacing Co.

"Effect of Time, Temperature and Prior Structure on the Hardenability of Several Alloy Steels," by J. Welchner, E. S. Rowland and J. E. Ubben, Timken Roller Bearing Co.

SIMULTANEOUS SESSION

"The Stress Distribution at the Neck of a Tension Specimen," by P. W. Bridgman, Harvard University.

"Notched Bar Tensile Test Characteristics of Heat Treated Low Alloy Steels," by G. Sachs, J. D. Lubahn and L. J. Ebert, Case School of Applied Science.

"The Strength of Heat-Treated Alloy Steel Bolts," by G. Sachs, P. S. Cole and R. A. Roth, Case School of Applied Science.

FRIDAY MORNING, OCT. 22

"The Emissivity of Molten Stainless Steels," by George N. Goller, Rustless Iron & Steel Corp.

"Quenching Rate Versus Graphite Formation in Pre-Quenched White Cast Iron," by Orien W. Simmons, Battelle Memorial Institute.

"Pseudomorphs of Pearlite in Quenched Steel," by Owen W. Ellis, Ontario Research Foundation.

SIMULTANEOUS SESSION

"Structural Changes During the Tempering of High Carbon Steel," by D. P. Antia, S. G. Fletcher and Morris Cohen, Massachusetts Institute of Technology.

"The Effect of Carbon on the Tempering of Steel," by Stewart G. Fletcher and Morris Cohen, Massachusetts Institute of Technology.

"The Tempering of Nickel and Nickel-Molybdenum Steels," by Dara P. Antia and Morris Cohen, Massachusetts Institute of Technology.

"Effect of Quenching-Bath Temperature on the Tempering of High Speed Steel," by Paul Gordon and M. Cohen, Massachusetts Institute of Technology, and R. S. Rose, Vanadium-Alloys Steel Co.

SIMULTANEOUS SESSION

"An Emergency Heat Resistant Alloy," by O. E. Harder and James T. Gow, Battelle Memorial Institute.

"An Optimum Silicon Range in Plain and 2.0 Per Cent Chromium Cast Irons Exposed to Elevated Temperatures," by C. O. Burgess and R. W. Bishop, Union Carbide & Carbon Res. Labs.

"Creep Strength, Stability of Microstructure and Oxidation Resistance of Chromium-Molybdenum and Chromium-Nickel Steels," by R. F. Miller, W. G. Benz and M. J. Day, United States Steel Corp.

The War Production Clinics

Sessions on Production Conservation and Post-War Planning

A series of 17 practical sessions on production, conservation and post-war planning in the metal industries is announced for presentation during the National Metal Congress at the Palmer House, Chicago, the week of Oct. 18.

The most pressing problems of today and tomorrow will be discussed by nearly 200 outstanding men in industry and it is expected that these sessions will provide a clearing house for the practical solution of production problems, of conservation demands and so on.

These 17 sessions will be launched Monday afternoon, Oct. 18, with a discussion on advanced quenching practice — a problem which has assumed real importance during the war, especially in connection with armorplate.

Some of the other topics to be discussed are as follows:

Post-War Planning in Non-Ferrous Metals.

Fundamental Changes that may Reasonably be Expected in Metallurgy and Metals Generally — Melting, Refining, Fabrication and Treatment from an After-the-War Point of View.

Light Weight Construction for the Post-War Era — Aluminum, Magnesium, Stainless Steels, Plastics and Wood.

Purchase of Steels on Expected Performance rather than on Chemical Analysis.

Non-Destructive Tests —Inspection of Rough Material, Appraisal of Surface Finishes, X-Ray Inspection, and Magnaflux.

Powder Metallurgy — Raw Materials, Manufacture of Powders, and Post-War Possibilities.

Special Alloy Addition Agents for Steel.

Steel Making Methods.

Foundry Metallurgy — Melting Methods, High Strength Cast Irons and Steels, Centrifugal Casting and Continuous Casting.

Modern Practices in Surface Hardening.

Control of Quality by Inspection.

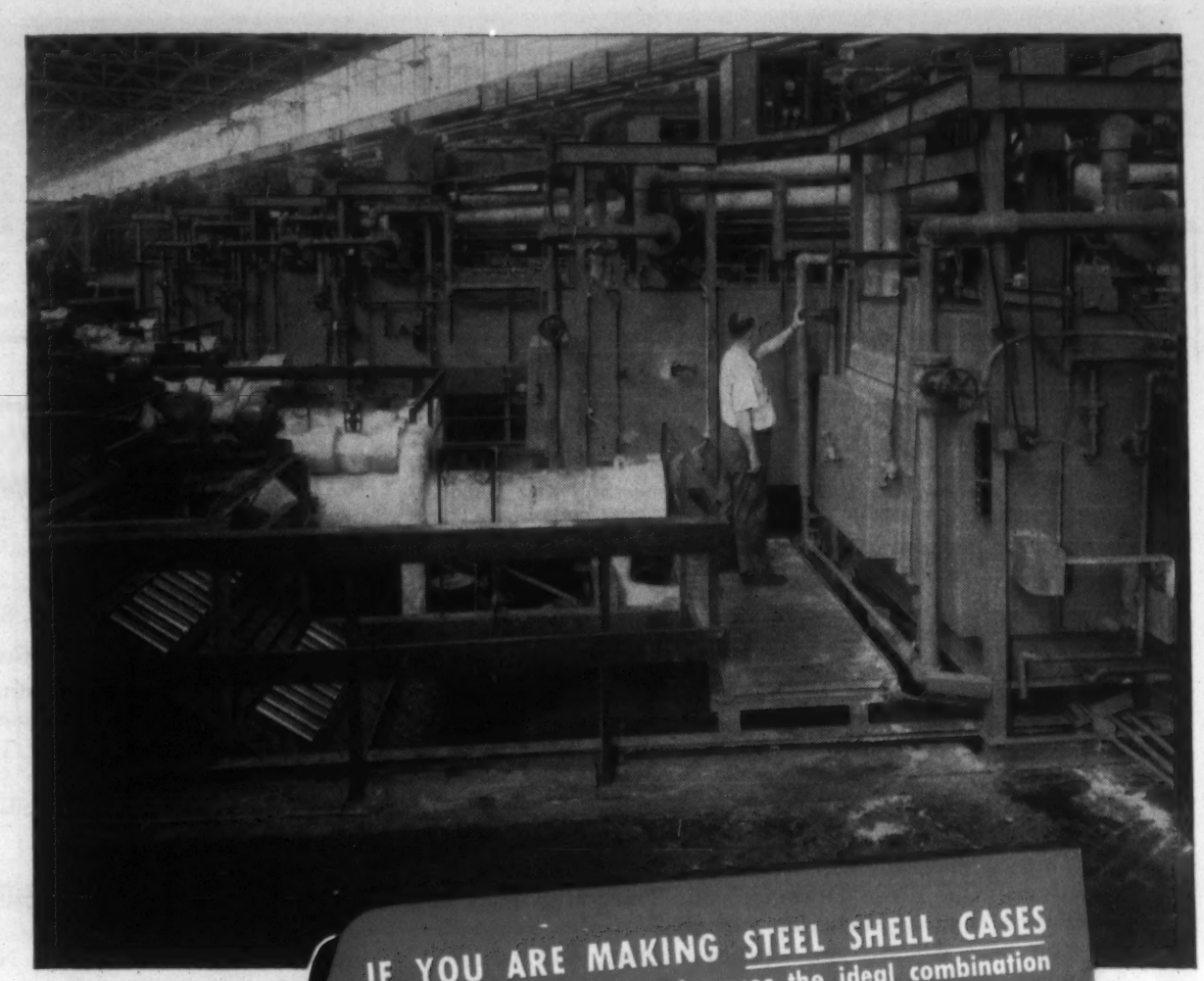
National Emergency Steels.

Salvaging Metal including Battlefield Scrap, Aluminum and Brass Cartridge Scrap and so on.

Magnesium and Magnesium Alloys including Dow Chemical Co.'s Film on the "Working of Magnesium."

Special Finishes and Metallic Protection.

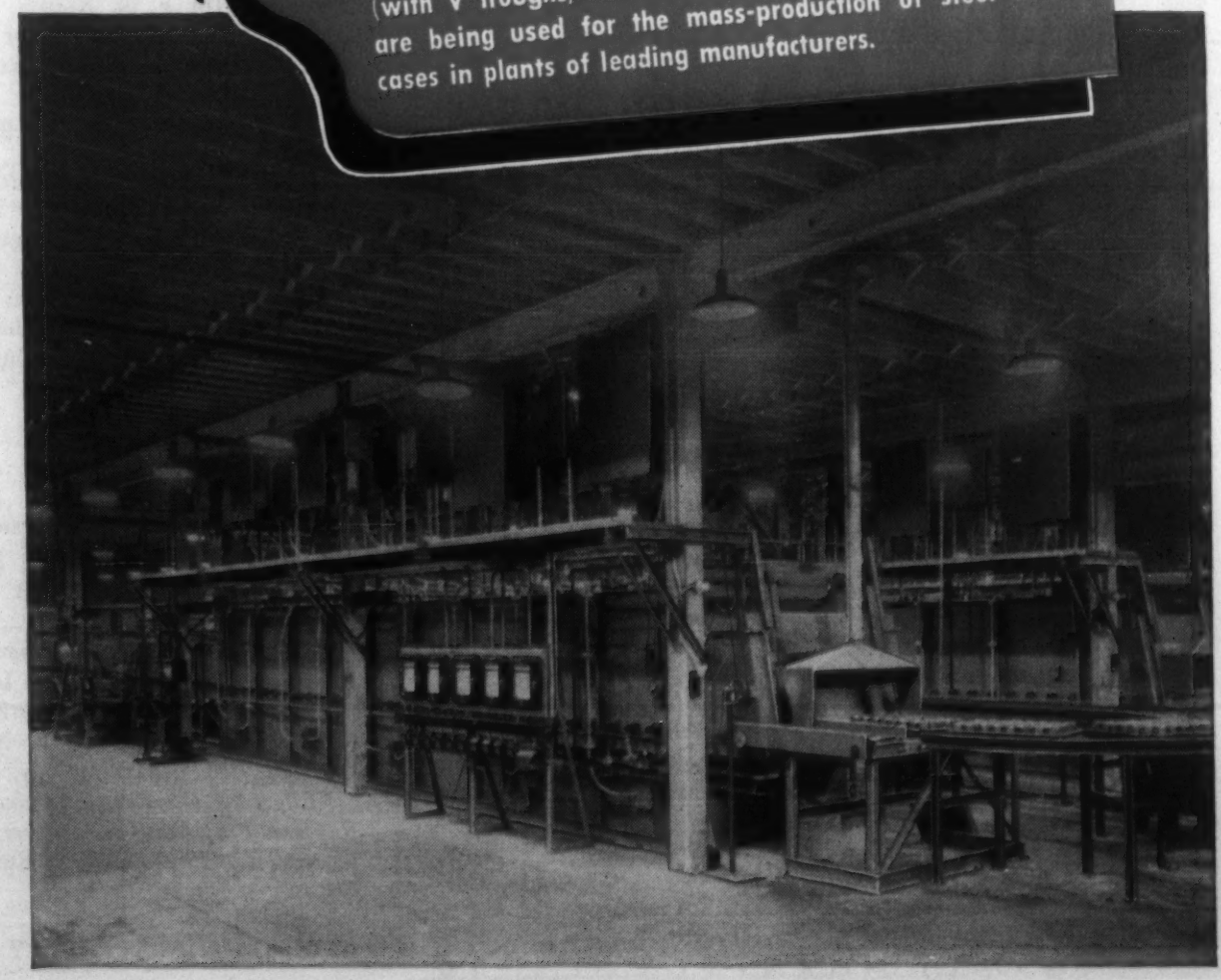
These special sessions are in addition to the regular technical sessions of the Congress.



The pusher furnace, with V troughs—highly recommended for heating parts in protective atmosphere for hardening and drawing. Typical applications include shell cases, cylinders, round pins, and similar parts which can be pushed against each other and guided through the furnace by troughs.

IF YOU ARE MAKING STEEL SHELL CASES

you will find these two furnaces the ideal combination for fast, accurate heat-treating: the roller-hearth furnace for annealing after drawing, and the pusher furnace (with V troughs) for hardening. Both of these furnaces are being used for the mass-production of steel shell cases in plants of leading manufacturers.



The roller-hearth furnace—the most popular continuous-type furnace for all-round purposes. Used for brazing, annealing, normalizing, malleableizing, hardening, and sintering. Can be made to perform automatically practically any combination of cycles desired, such as brazing, cooling, reheating, and automatic quenching for hardening. Will handle either light or heavy parts in large quantities and at high speed. Work can be placed either on lightweight trays or directly on the driven rolls at the charging door. Automatic controls carry the charge through the furnace and discharge it without attention.

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Tentative Technical Program of the

Metals Divisions of the A. I. M. E.

This is the 16th consecutive year in which the metal divisions of the A.I.M.E. are cooperating with the A.S.M. in promoting the National Metal Congress.

It is pointed out that this year's meeting will be one of the most interesting in many years. It is designed to appeal to members particularly interested in metals, non-metallic minerals and fuels.

Contrary to previous meetings, the one this year is scheduled to commence earlier than the formal opening of the Congress, due to the arranging of a regional meeting, preceding the sessions of the metal divisions. The first session is arranged for Saturday afternoon as part of the regional meeting, Oct. 16, with the last one scheduled for Wednesday, Oct. 20. For Sunday, Oct. 17, a field trip to a nearby coal mine is planned with two addresses on fuels later in the day.

Three symposiums will feature the sessions of the metal divisions: On "Deep Drawing," on "Practical Aspects of Diffusion" and on "Cohesion Strength."

The joint regional and divisional dinner will be held Monday evening.

All activities will be carried out at the Hotel Sherman, headquarters of the A.I.M.E.

The tentative technical programs are as follows:

Regional Meeting

SATURDAY AFTERNOON, OCT. 16

SESSION ON MAGNESIUM

"The Pidgeon Process," by R. L. Sebastian, W.P.B.

"Operations at Basic Magnesium, Inc.," by a staff member of Basic Magnesium, Inc.

"The Hausgirg Process," by T. A. Dungan, Mgr., Permanente Corp.

"Magnesium Metal for Present and Post War Uses," by Frank G. Breyer, Singmaster and Breyer, and Consultant, W.P.B.

Iron and Steel Division

MONDAY NOON, OCT. 18

Luncheon and Business Meeting of Physical Chemistry of Steel-Making Committee, T. S. Washburn, Chairman.

MONDAY AFTERNOON, OCT. 18

SYMPOSIUM ON DEEP DRAWING

"Orientation in Low-Carbon Deep Drawing Steel," by James K. Stanley, Res. Lab., Westinghouse Electric & Mfg. Co.

"Aging and the Yield Point of Steel," by J. L. Low, Jr., Carnegie-Illinois Corp., and Maxwell Gensamer, Carnegie Inst. of Tech.

TUESDAY MORNING, OCT. 19

SESSION ON HARDENABILITY

"The Influence of Various Elements on the Position of the Eutectoid in the Iron-Carbon (Carbide) *System,"* by Carl L. Shapiro, Consulting Metallurgist and Jerome Strauss, Vanadium Corp. of America.

"The Effect of Quenching Temperature on the Results of the End Quench Hardenability Test," by Clarence E. Jackson and A. L. Christianson, Naval Research Laboratory.

"The Effects of 16 Alloying Elements on the Hardenability of Steel," by I. R. Kramer and R. H. Hafner, Naval Research Laboratory.

"The Effect of Some Alloying Elements on Hardenability," by Walter Crafts and John L. Lamont, Union Carbide & Carbon Res. Lab.

TUESDAY AFTERNOON, OCT. 19

SYMPOSIUM ON COHESIVE STRENGTH

(Joint session with Institute of Metals Division)

"The Significance of Cohesive Strength," by Maxwell Gensamer, Carnegie Inst. of Technology.

"The Theory of Cohesive Strength," by D. J. McAdam. Jr., National Bureau of Standards.

Institute of Metals Division

MONDAY MORNING, OCT. 18

SYMPOSIUM ON PRACTICAL ASPECTS OF DIFFUSION

"The Practical Aspects of Diffusion," by R. F. Mehl, Carnegie Inst. of Technology.

"Influence of Gas-Metal Diffusion in Metal Fabricating Processes," by F. N. Rhines, Carnegie Inst. of Technology.

"Diffusion in Degassing of Metals," by F. J. Norton and A. L. Marshall, General Electric Co.

MONDAY AFTERNOON, OCT. 18

SYMPOSIUM ON DIFFUSION (Cont.)

"Diffusion in Metals," by Marie L. V. Gayler, National Physical Laboratory, Teddington, England.

"Diffusion in Ihrigizing," by H. K. Ihrig, Dir. of Laboratories, Globe Steel Tubes Co.

"Diffusion in Indium Plating," by A. A. Smith, Jr., American Smelting & Refining Co.

"Diffusion in Chromizing," by I. R. Kramer, Met., Naval Research Laboratory.

TUESDAY MORNING, OCT. 19

SESSION ON PHYSICAL METALLURGY

"The Constitution of the Lead-Antimony and Lead-Antimony-Silver Systems," by B. Blumenthal, American Smelting & Refining Co.

"Metallography with the Electron Microscope," by Charles S. Barrett, Carnegie Inst. of Tech.

"The Structure of Copper-Zinc Alloys Oxidized at Elevated Temperatures," by F. N. Rhines and B. J. Nelson, Carnegie Inst. of Technology.

"Effect of Cooling Rate and Minor Constituents on the Rupture Properties of Copper at 200 deg. C.," by D. L. Martin and E. R. Parker, Research Lab., General Electric Co.

WEDNESDAY, OCT. 20

There will be no technical sessions of the Metals Divisions Wednesday morning, so that members may attend the *Campbell Memorial Lecture* of American Society for Metals:

"Structural Premises of Strain Hardening and Recrystallization," by C. H. Mathewson, Prof. of Metallurgy, Yale University.

Executive Committee, Institute of Metals Division, Luncheon and Business Meeting.

FERROUS AND NON-FERROUS ALLOYS

• • LEAD • • ZINC ALLOYS

S-P.M. Co. Alloy No.	Average or Minimum Physical Properties: Tensile Strength Lbs. Per Sq. In.	Yield Point Lbs. Per Sq. In.	Elong. in 2" Per-centage	Com-pression Yield Lbs. Per Sq. In.	Brinell 500 Kg.	Wt. per Cubic In.	APPLICATIONS**: Bearings	Bushings	Liners	Sleeves	Glands	Ball Bearing Cages	Rings - Washers	Gears - Nuts	Marine Bearing Housings	Roll Covers Drums - Rolls	S-P.M Co. Alloy No
1	28,500	19,500	15.0	12,000	60	.318	X	X	X	X	X		X		X		1
2	29,000	21,500	8.0	15,000	65	.322	X	X									2
3	32,000	19,000	16.0	16,000	68	.315			X	X						X	3
4	38,000	21,000	20.0	16,500	70	.315	X		X	X			X	X		X	4
5	40,000	20,000	26.0	18,000	60	.315			X	X	X		X		X	X	5
8	25,000	15,000	8.0			.320	X		X								8
9	29,500	22,000	10.5	20,440	62	.318	X	X			X		X				9
10	21,000	20,000	1.0		45	.328	X										10
11	25,000	15,000	8.0	19,600	50	.325	X		X				X				11
17	32,000	20,000	18.0	20,340	67	.318			X	X	X		X			X	17
18	35,000	21,500	12.0	23,600	85	.316			X				X	X			18
19	42,000	21,000	25.0	20,340	70	.315			X	X			X			X	19
21	40,000		.5		135	.314	X										21
22	37,000		1.0	18,000	100+	.314	X										22
23	32,000	23,000	12.0		75+	.313	X	X		X			X				23

• • COPPER - ZINC ALLOYS

Alloy No.	Tensile Strength	Yield Point	Elong. in 2"	Com-pression	Brinell	Wt. Cu. In.											
12	28,000	16,000	22.0		65	.283			X			X	X				12
14A	80,000	40,000	12.0	35,000	170*	.274				X				X			14A
14B	65,000	32,500	20.0	18,500	115	.273	X			X				X			14B
14C	75,000	35,000	15.0		140*	.280				X				X			14C
15	72,000	33,000	25.0		143*	.288			X	X		X		X			15
15S	90,000	40,000	18.0		174*	.289			X	X				X			15S
15HT	110,000	55,000	12.0		223*	.290			X	X				X			15HT
16B	62,000	35,000	18.0		120	.280				X			X				16B
24	30,000	18,000	18.0		75	.280		X	X			X			X		24

• • MONEL METAL • ALUMINUM • COPPER

Alloy No.	Tensile Strength	Yield Point	Elong. in 2"		Brinell	Wt. Cu. In.											
13A	45-50,000	30,000	24.0		99	.316		X					X			X	13A
13B	45-50,000	20-25,000	35-40		90	.318		X					X			X	13B
20	34,000	17,500	30.0		50	.306					X		X				20
25	65,000	32,500	25.0		130	.320			X	X						X	25
26	70,000	38,000	13.0		150*	.322			X	X						X	26

Copper — Made for Special Applications and Limited Conductivity and Corrosion Problems — Write for information.

ALLOYED CAST IRON

Alloy No.	Tensile Strength	Transverse Test: Minimum Load	Transverse Test: Minimum Deflection	Brinell	Wt. Cu. In.											
29	28,000 Min.	2,000 Lb.	.24"	175-190*	.262		X	X				X			X	29
30	40-55,000	3,000-3,600 Lb.	.25" to .35"	225-275*	.263		X	X	X			X			X	30
31	40,000 Min.	3,000 Lb.	.30"	255-300*	.262				X						X	31
28	20-25,000	3,000-4,000 Lb.	.20" to .30"	120-180*	.270			X	X	X					X	28

*Brinell at 3,000 Kg. load.

**Tabulated "Applications" must by necessity be general in scope—Write for our recommendations.

For additional copies of this Chart and other information on Centrifugal Castings, write

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Tentative Technical Program of the

American Welding Society

A technical program of broad scope and high quality will be presented to the welding engineers who attend the annual convention of the American Welding Society which is held as part of the National Metal Congress in Chicago, Oct. 18 to 22.

Over 50 papers have been scheduled for delivery at the 19 sessions during the first 4 days of Congress. Simultaneous sessions are arranged for the morning and afternoon of each day. All meetings will be held at the Hotel Morrison, headquarters of the Society.

The tentative technical program follows:

MONDAY MORNING, OCT. 18

Session on Cutting

"Flame Cutting Heavy Sections and Large Diameters," by R. L. Deily and E. Benyo, Bethlehem Steel Co.

"Welding and Cutting in Steel Mills," by T. W. Morgan, American Rolling Mill Co.

"Electronic Control of Gas-Cutting Machines," by R. D. McComb, General Electric Co.

"Machine Cutting for Assembly Line Fabrication," by Charles O. Adams, Delco Products Div.

MONDAY AFTERNOON, OCT. 18

Railroad Session

"The Welded Locomotive Boiler," by E. G. Young, University of Illinois.

"Welding as It Applies to Railroads," by Robert Moran, Missouri Pacific R. R.

"Railroad Shop Welding and Cutting," by J. W. Kenefic, Air Reduction Sales Co.

"Welding of Railroad Transport Equipment," by C. Dreutzler, Electro-Motive Corp.

Weldability Session

"Investigations at Lehigh," by Gilbert E. Doan, Lehigh University.

"Investigations at Rensselaer Polytechnic Institute," by Wendell F. Hess, Rensselaer Polytechnic Institute.

"The Weldability of Silicon Steels," by C. E. Jackson and G. G. Luther, Naval Research Laboratory.

"Weld Bead Hardness Tests on Plain Carbon, Nickel and Nickel-Chromium Steels," by Oscar E. Harder and C. B. Voldrich, Battelle Memorial Institute.

"Evaluation of Weldability by Correlation of Electrical Constants," by Victor Paschkis, Columbia University.

MONDAY EVENING, OCT. 18

Educational Session

General Electric Film on Atomic Hydrogen Welding

"An Address on Welding in Ordnance Construction," by Col. S. B. Ritchie, Chief of the Service Branch of the Chief of Ordnance Office.

TUESDAY MORNING, OCT. 19

Session on Resistance Welding

"Flash Welding of Alloy Steels," by C. M. Manzer, General Electric Co.

"The Spot Welding of Heavy Gauges of Carbon and Alloy Steels," by John C. Barrett, Taylor-Winfield Corp.

"The Spot Welding of the Carbon Steels S.A.E. 1020, S.A.E. 1035 and S.A.E. 1045 in the 0.040-In Thickness," by Wendell F. Hess, Rensselaer Polytechnic Institute.

Session on Tubing

"Welded Steel Tubing—Quality Control and Application," by R. D. Malm, Clayton Mark & Co.

"Machine Welded Metal Tubing," by G. C. Gridley, Mechanics Universal Joint Div., Borg-Warner Corp.

"Oxy-Acetylene Tube Welding," by A. C. Weber, Laclede Steel Co.

Session on Flame Hardening and Hard Facing

"Ordnance Flame Hardening," by S. Smith and J. G. McIlhiney, Air Reduction Sales Co.

"Hard Facing in the War on Wear," by J. A. Gallaher, Haynes Stellite Co.

"Hard Facing," by F. G. Jones, Wall-Colmonoy Corp.

Session on Ships

"Welding in Ship Construction," by H. A. Matis and A. M. Unger, Pullman-Standard Car Mfg. Co.

"Prefabrication of Welded Ships in a Structural Steel Plant," by E. T. Blix and J. C. Arntzen, Mississippi Valley Structural Steel Co.

"Control of Welding in Ship Construction," by R. W. Brendle, Tampa Shipbuilding Co.

TUESDAY AFTERNOON, OCT. 19

Session on Resistance Welding

"Why the Weld Recorder," by J. R. Fetcher and J. van den Beemt, E. G. Budd Mfg. Co.

"Double Pressure Systems as Applied to Resistance Welding Machines," by S. M. Humphrey, Taylor-Winfield Corp.

"Stored Energy Welding of Mild Steel," by J. M. Diebold, Yellow Truck & Coach Mfg. Co.

"Flash Welding of Nickel and High Nickel Alloys," by W. F. Hess and A. Muller, Rensselaer Polytechnic Institute.

Session on Ships

"Planning for Production Welding and Cutting in Modern Shipyards," by W. B. Bowen, Ingalls Shipbuilding Corp.

"Thermit Welding in Maritime Commission Work," by J. H. Deppeler, Metal & Thermit Corp.

"Longitudinal Welded Joints," by A. G. Bissell, Bureau of Ships, Navy Dept.

Research Session

"Fatigue Strength of Fillet Welded Joints," by W. M. Wilson, University of Illinois.

"Some Notes on Evaluating the Weldability of Alloy Steels," by Lt. S. A. Herres, Watertown Arsenal.

"Investigation of a Normalizing Procedure to Improve the Grain Structure of Welds in Carbon-Molybdenum Pipe," by I. A. Rohrig, D. H. Corey and Sabin Crocker, The Detroit Edison Co.

"Correlation of Structure and Strength of Spot Welds in Aluminum Alloys," by Dana Smith and F. Keller, Aluminum Co. of America.

WEDNESDAY MORNING, OCT. 20

Aircraft Session

"Fatigue Strength of Welded Aircraft Joints," by T. V. Buckwalter, The Timken Roller Bearing Co.

"The Spot Weldability of Low Carbon and Other Aircraft Steels," by L. C. Bibber and Julius Heuschkel, Carnegie-Illinois Steel Corp.

"Weldability Tests of Aircraft Structural Steels," by C. B. Voldrich and R. D. Williams, Battelle Memorial Institute.

Typical Applications

Problem: A New England war plant, purchasing steel castings from an outside source, was experiencing a reject rate of 75% after machining. Three man-hours were lost on each rejected unit.

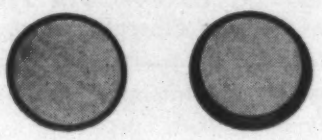
Solution: X-ray inspection.

Result: Defective castings detected before machining. Production accelerated. Tremendous saving effected in time, labor and materials.

Problem: Weight of bomber landing gear was excessive. Could weight be reduced without sacrifice of safety factor?

Solution: Analysis of stressed part with X-ray.

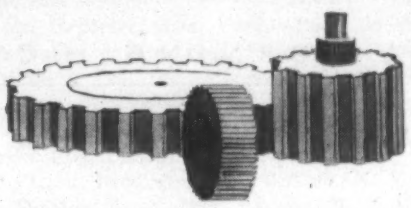
Result: Deadweight in casting safely reduced by 50%. Tons of critical material saved . . . load carrying capacity of plane increased.



Problem: Solenoid plunger in communications equipment wouldn't function properly. Engineers certified design as okay; factory said manufacture was okay; part appeared perfect.

Solution: Examination with X-ray.

Result: Picture disclosed that when machined, chromium plating on one side of plunger was heavier than on other—reducing its magnetic properties.



Problem: Inspectors questioned mesh and clearance between gears and housings in tab gear boxes for fighter planes. Only proof of accuracy was check of production drawings.

Solution: A look inside gear housing with X-ray.

Result: Inspectors given X-ray proof that each completed gear unit was constructed properly . . . or rejected before shipment.

Two Proposals

PROPOSAL NO. 1 Send for our new book on Industrial X-ray Inspection. The most complete book of its kind, it is packed with practical, understandable, question-answering information on how and where to use industrial X-ray inspection — how to set up an X-ray department — how to select the right equipment — range of equipment available. Ask for B-3159.

PROPOSAL NO. 2 If you want fast action on your problem just tell us to send a Westinghouse X-ray Specialist. He'll respond promptly—and competently.

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City.....State.....

Tentative Technical Program of the

Wire Association

As has been the custom for several years, the annual convention of the Wire Association will be held in cooperation with the National Metal Congress in Chicago, Oct. 18 to 21. The usual number of technical papers, lectures and special addresses have been scheduled, embracing both ferrous and non-ferrous topics. All meetings will be held at the headquarters of the Association, the LaSalle Hotel.

The annual Mordica Memorial Lecture will be delivered this year on Wednesday morning by Flint C. Elder, of the American Steel & Wire Co.

The tentative program of papers is as follows:

MONDAY AFTERNOON, OCT. 18

Technical Session

"Designing Mills for Government Purposes," by Paul M. Mueller, Revere Copper & Brass Co.

TUESDAY MORNING, OCT. 19

Technical Session

"Work Simplification," by Mogensen (Lecture and Motion Picture).

"Steel Rope Wire Drawing Practices," by John C. Aiken, Jones & Laughlin Steel Corp.

TUESDAY AFTERNOON, OCT. 19

Technical Session

"The Use of Lead Base Coatings as a Substitute for Zinc," by C. A. Kellogg, Continental Steel Corp.

"Plating of Steel Wire," by Rodman R. Tatnall, Wickwire Spencer Steel Co.

WEDNESDAY MORNING, OCT. 20

Technical Session

"Mordica Memorial Lecture," by Flint C. Elder, American Steel & Wire Co.

THURSDAY MORNING, OCT. 21

Technical Session

"Drawing of Fibers," by Sydney Coppick.

"Properties and Uses of Vinyl Resins for Wire and Cable," by G. A. Fowles, B. F. Goodrich Co.

THURSDAY AFTERNOON, OCT. 21

Technical Session

"Glass Insulation; Its Uses and Properties," by L. T. Russell, Owens-Corning Fiberglas Corp.

"The Application of Synthetic Compounds to Wire by Extrusion," by H. K. Intemann, Halowax Products Div., Union Carbide & Carbon Corp.

"Rubber in Industry"—Motion Picture.

AWS Program — *Continued from page 712*

Session on Non-Ferrous Welding and Brazing

"Modern Welding Methods for Copper and Copper Alloys," by J. J. Vreeland, Chase Brass & Copper Co., Inc.

"Carbon Arc Welding of Naval Brass," by Kenneth I. Walker, Foster Wheeler Corp.

"Aluminum Brazing Sheet—Fundamentals of Metal Flow," by M. A. Miller, Aluminum Research Laboratories.

Session on Piping

"Oxy-Acetylene Distribution Systems," by D. F. Guthrie and R. W. Stewart, Air Reduction Sales Co.

"Large Welded Pipe Lines," by L. G. Christofferson, Chicago Bridge & Iron Co.

"Weldability of 27 Per Cent Chrome Steel Pipe," by R. A. Mueller, I. H. Carlson and E. R. Seabloom, Crane Co.

WEDNESDAY AFTERNOON, OCT. 20

Aircraft Session

"The Heliarc Welding of Magnesium Alloys as Used in Airplane Fabrication and Substitution for Critical Materials," by T. E. Piper, Northrop Aircraft, Inc.

"Fatigue Studies of Welded Test Triangular Structures with NE8630 Steels," by A. J. Williamson, Summerill Tubing Co.

"Fabrication and Welding of Aircraft Exhaust Tubing—Manifolds and Headers," by C. D. LaFond, Buhl Stamping Co.

"Metallic Arc Welded X-4130 Steel Tubing," by W. T. Tiffin, University of Oklahoma.

Session on Inspection, Qualification and Training

Symposium on Applicable Methods of Inspection of Arc Welding for (1) Shipbuilding, by J. Lyell Wilson; *(2) Structural,* by R. B. Lincoln; *(3) Pressure Vessels and Piping,* by W. D. Halsey; *(4) Aircraft,* by J. B. Johnson; *(5) Machinery,* by N. L. Mochel.

"General Problems of Training Welding Operators," by A. N. Kugler, Air Reduction Sales Co.

Session on Repair and Maintenance

"Bronze Welding in the Design and Maintenance of Forming Dies," by C. E. Swift, Ampco Metal, Inc.

"The Job Shop—Past, Present and Future," by F. W. Shackleton, Central Ohio Welding Co.

"Maintenance of Tools and Equipment," by T. B. Jefferson, *The Welding Engineer.*

"Reclamation of Tools by Low Temperature Brazing," by W. A. Johnson, International Harvester Co.

THURSDAY MORNING, OCT. 21

Aircraft Session

"Quality Control of Aircraft Spot Welding," by Nathan C. Clark, Lockheed Aircraft Research Laboratory.

"The Application of Flash Welding in Airplane Construction," by C. B. Smith, Douglas Airplane Co.

"Spot Weld Joint Efficiency for Aluminum Alloys," by C. W. Steward, Curtiss-Wright Corp. Research Laboratory.

"Spot Welding of Magnesium Alloys," by W. S. Loose, Aircraft Welding Research Committee WRC.

Production Session

"Automatic Arc Welding Solves Production Problems," by R. F. Wyer, General Electric Co.

"Transition from Riveted to Welded Construction of Light Tanks," by Wm. Osha and J. W. Sheffer, American Car & Foundry Co.

"Welding of Armored Tanks," by William Boese, Pullman Standard Car Mfg. Co.

Session on Pressure Vessels

"War Emergency Codes for Welded Pressure Vessels," by E. R. Fish, Hartford Steam Boiler Inspection & Insurance Co.

"The Hammer Test for Welded Pressure Vessels: an Investigation," by C. O. Dohrenwend, Armour Research Foundation.

List of EXHIBITORS

Acme Tool Co., New York.—Room 802.
Agfa Ansco Corp., Binghamton, N. Y.—Room 714.
Ajax Electric Co., Inc., Philadelphia.—Room 801.
Alien Property Custodian, Chicago.—Room 724.
Alloy Casting Co., Champaign, Ill.—Room 787.
Alox Corp., Niagara Falls, N. Y.—Room 742.
Aluminum Co. of America, Pittsburgh.—Rooms 705 and 731.
American Allsafe Co., Buffalo, N. Y.—Room 814.
The American Brass Co., Waterbury, Conn.—Rooms 836 and 838.
American Car & Foundry Co., New York.—Room 859.
American Chain & Cable Co., Bridgeport, Conn.—Room 729.
American Gas Furnace Co., Elizabeth, N. J.—Room 882.
American Machine & Metals, East Moline, Ill.—Room 848.
American Machinist, New York.—Room 785.
American Magnesium Corp., Cleveland.—Rooms 705 and 731.
American Society for Metals, Cleveland.—Rooms 942W and 944W.
Ampco Metal, Inc., Milwaukee.—Room 946W.
F. E. Anderson Oil Co., Portland, Conn.—Room 749.
Andresen, Inc., Pittsburgh.—Room 967W.
Atlas Publishing Co., New York.—Room 965W.
Automotive and Aviation Industries, Philadelphia.—Room 977W.

Baldwin Southwark Div., Philadelphia.—Room 828.
Barrett-Cravens Co., Chicago.—Room 803.
Bausch & Lomb Optical Co., Rochester, N. Y.—Room 706.
Berco Mfg. Co., Chicago.—Room 903.
Brickseal Refractory Co., Hoboken, N. J.—Room 942.
Brush Development Co., Cleveland.—Room 843.
A. I. Buehler, Chicago.—Room 905W.
Bell & Gossett, Chicago.—Room 788.
Blue Book, Chicago.—Room 878.

Canadian Radium & Uranium Corp., New York.—Room 717.
Andrew C. Campbell Div., Bridgeport, Conn.—Room 729.
Central Scientific Co., Chicago.—Room 775.
Chicago Flexible Shaft Co., Chicago.—Room 761.
Chicago Steel Foundry Co., Chicago.—Room 727.
Cities Service Oil Co., New York.—Room 807.
Coffing Hoist Co., Danville, Ill.—Room 943.
Commerce Pattern Foundry & Machine Co., Detroit.—Room 912.
Conco Engineering Works, Mendota, Ill.—Room 708.
H. D. Conkey Co., Mendota, Ill.—Room 708.
Continental Industrial Eng'rs, Chicago.—Room 905.
Crown Rheostat & Supply Co., Chicago.—Room 806.
Continental Machines, Inc., Minneapolis, Minn.—Rooms 833 and 834.
The Chilton Co., Philadelphia.—Room 825.

Deepfreeze Div. of Motor Products Corp., North Chicago, Ill.—Room 782.
Daily Metal Reporter, New York.—Room 965W.
A. P. De Sanno & Son, Inc., Phoenixville, Pa.—Room 777.
W. C. Dillon & Co., Inc., Chicago.—Room 809.
Diversey Corp., Chicago.—Room 818.
Dravo Corp., Pittsburgh.—Room 960.
The Drever Co., Philadelphia.—Room 760.
Du Bois Plastic Products, Inc., Buffalo, N. Y.—Room 814.
Allen B. DuMont Labs. Inc., Passaic, N. J.—Rooms 841 and 842.
Do-All Midwest Co., Chicago.—Room 833 and 834.
H. W. Dietert Co., Detroit.—Room 879.

Eastman Kodak Co., Rochester, N. Y.—Room 849.
Engis Equipment Co., Chicago.—Room 979W.
Eutectic Welding Alloys, Inc., New York.—Room 711.

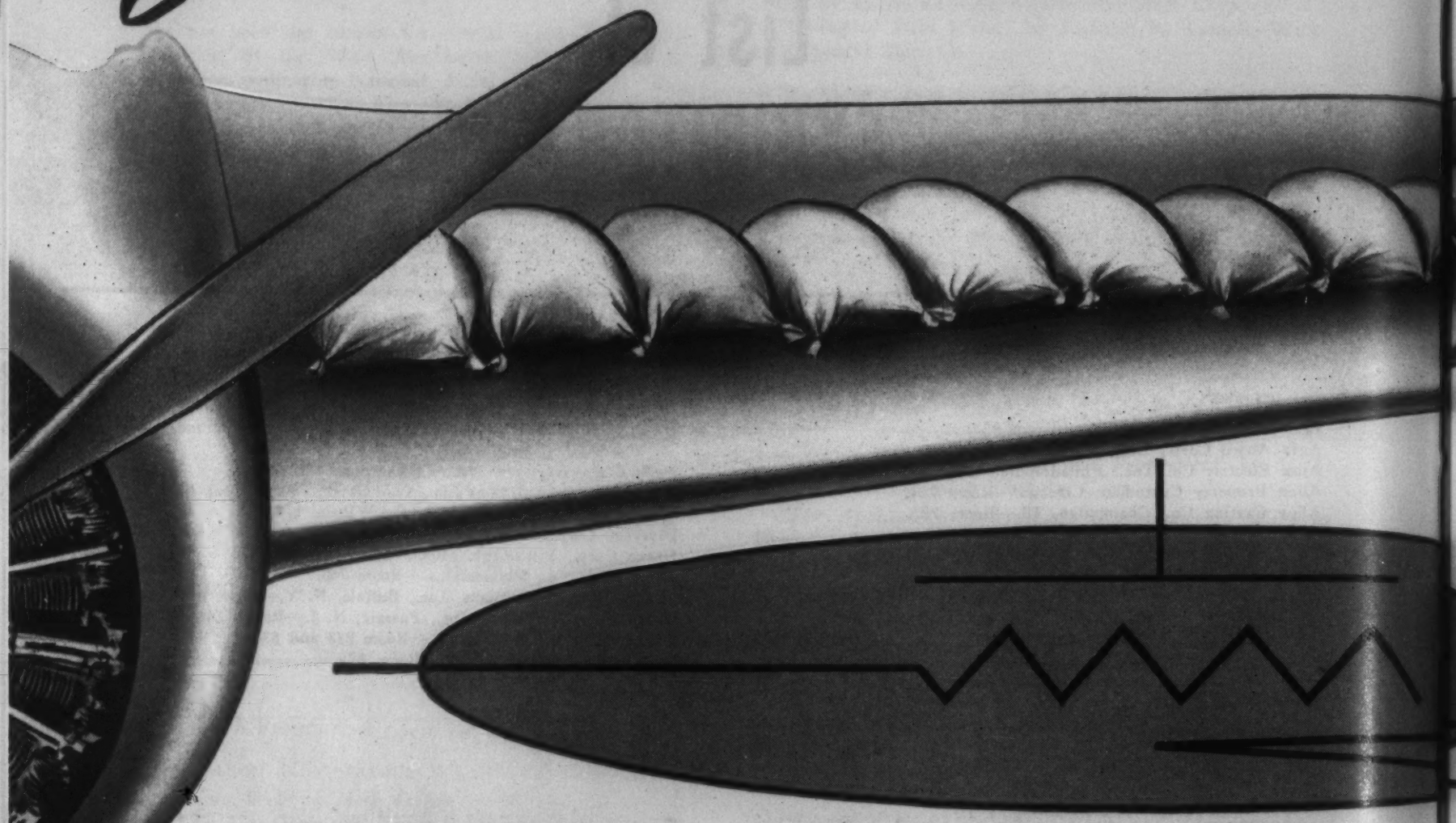
Federal Telephone & Radio Corp., Newark, N. J.—Room 735.
Federal Products Corp., Providence, R. I.—Room 815.
Federal Refractories Corp., Akron, O.—Room 855.
Firth Sterling Steel Co., McKeesport, Pa.—Rooms 831 and 832.

General Alloys Co., South Boston, Mass.—Rooms 701 and 702.
General Electric X-Ray Corp., Chicago.—Room 728.
Girdler Corp., Louisville, Ky.—Room 733.
Globe Machine & Stamping Co., Cleveland.—Room 719.
Claud S. Gordon Co., Chicago.—Room 703.
Gray-Mills Co., Chicago.—Rooms 963W and 980W.
Gaertner Scientific Co., Chicago.—Room 916.

Handy & Harman, New York.—Room 744.
H & H Research Co., Detroit.—Room 802.
Harnischfeger Corp., Milwaukee.—Room 813.

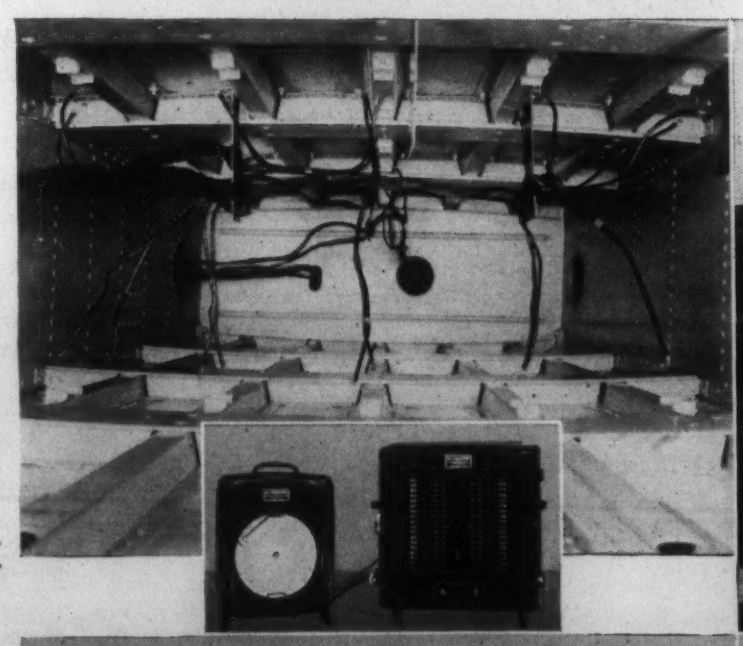
(Continued on page 724)

New REALMS OF

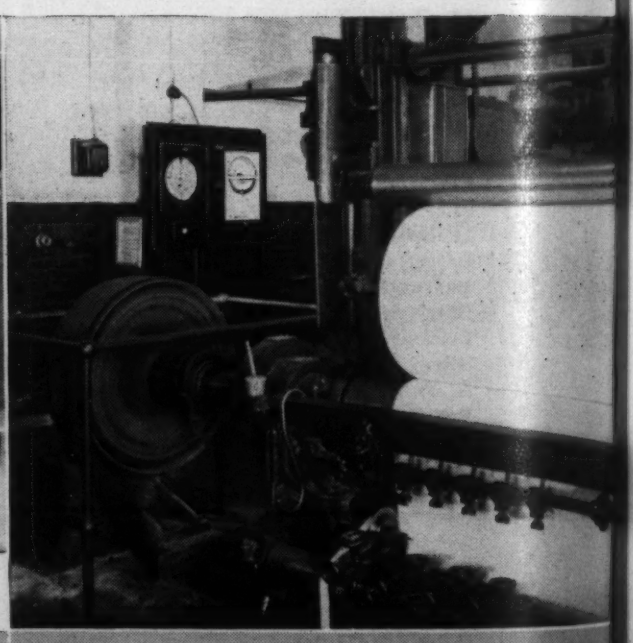


Electronic operation is now successfully applied to process measurements! The almost unbelievable simplicity of Foxboro DYNALOG* Instrumentation gives promise of new high degrees of usefulness in nearly every phase of industrial measurement.

**Registered name of Foxboro's electronic measuring and control instruments.*



Inside view of airplane wing showing SR-4 strain gages located at critical points. Inset is the automatic switching Electronic Recorder which furnishes exact, rapid readings of 48 test points.



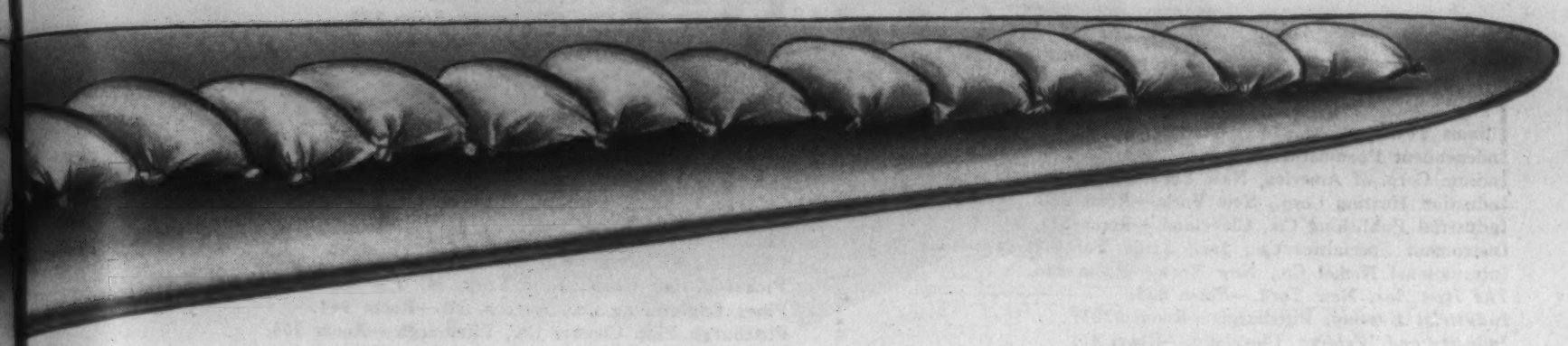
In paper-making industries, Foxboro Electronic corders continuously measure moisture of mo paper and automatically regulate steam to dr Sensitive to changes as small as 1/10 of 1%

DYNALOG

Reg. U.S. Pat. Off.

Electronic Measurement and Contro

PROCESS CONTROL..



...Foreshadowed by a War-Bird's Wing!

Through new-type measuring instruments designed and manufactured by Foxboro, exact records of the strains at all critical points in a warplane wing, under any test loading, are now being made *instantaneously!* Employing the super-sensitivity of electronics, these instruments are also making similar vital measurements above the clouds in fighting planes, down the ways in wartime ships, and through the desert in tanks.

Important Future Implications

Today, entire production of these extremely sensitive instruments is focused on war needs. But the way is opened to new realms of accuracy in controlling process variables. The same ease, accuracy and flexibility of measurement soon will be available to all industry, in Foxboro's revolutionary DYNALOG* Instrumentation.

Difficult measurement and control problems will be vastly simplified. For the first time, automatic control and instrument measurement will be applicable to many processes previously denied these benefits.

Creative Research Carries On

Electronic instrumentation is no new departure for Foxboro research or production. For years Foxboro engineers have worked with electronic principles of measurement and have perfected electronic instruments to facilitate moisture-and-weight measurements in paper and rubber industries. These widely-used Verigraph Recorders still hold a unique position.

Whenever today's advanced technology is converted to peacetime production, Foxboro DYNALOG Instrumentation will answer new demands for accuracy, speed and flexibility. **The Foxboro Company, 54 Neponset Avenue, Foxboro, Massachusetts, U. S. A.**

**Registered name of Foxboro's electronic measuring and control instruments*

by FOXBORO

REG. U. S. PAT. OFF.

ARMY E NAVY

(Continued from page 721)

Heat Treating and Forging, Pittsburgh.—Room 969W
Hevi Duty Electric Co., Milwaukee.—Room 759.
Hild Floor Machine Co., Chicago.—Room 958.
Hitchcock Publishing Co., Chicago.—Room 878.
A. F. Holden Co., New Haven, Conn.—Room 762.
W. J. Holliday & Co., Hammond, Ind.—Room 959.
E. F. Houghton & Co., Philadelphia.—Room 901W.

Illinois Testing Labs., Inc., Chicago.—Room 757.
Independent Pneumatic Tool Co., Chicago.—Room 726.
Indium Corp. of America, New York.—Room 835.
Induction Heating Corp., New York.—Room 860.
Industrial Publishing Co., Cleveland.—Room 811.
Instrument Specialties Co., Inc., Little Falls, N. J.—Room 713.
International Nickel Co., New York.—Room 886.
The Iron Age, New York.—Room 825.
Industrial Heating, Pittsburgh.—Room 970W.
Industry and Welding, Cleveland.—Room 811.
International Tel. & Tel. Co., Newark, N. J.—Room 735.

Johnson, S. C., & Son, Inc., Racine, Wis.—Room 820.
Jones Co., C. Walker, Philadelphia.—Room 907.

Kelley-Koett Mfg. Co., Covington, Ky.—Room 829.
Kennametal, Inc., Latrobe, Pa.—Rooms 948W and 949W.
Mr. Andrew King, Narbeth, Pa.—Room 780.
Kold-Hold Mfg. Co., Lansing, Mich.—Room 865.
Krembs & Co., Chicago.—Room 755.

Lepel High Frequency Labs., New York.—Room 763.
Lindberg Engineering Co., Chicago.—Room 765.
Lukens Steel Co., Coatesville, Pa.—Room 732.
Lukenweld, Inc., Coatesville, Pa.—Room 732.

Magnaflux Corp., Chicago.—Room 745.
Magnetic Analysis Corp., Long Island City, N. Y.—Room 756.
Marquette Mfg. Co., Minneapolis, Minn.—Room 856.
Mercury Mfg. Co., Chicago.—Room 817.
Metal Finishing, New York.—Room 968W.
Metal Industry Publishing Co., New York.—Room 968W.
Metallizing Co. of America, Chicago.—Room 903W.
Metals and Alloys, New York.—Room 758.
Metal Industries Catalog, New York—Room 758.
Metal Progress, Cleveland.—Rooms 942W and 944W.
Mill & Factory, Chicago.—Room 880.
Mine Safety Appliances, Pittsburgh.—Room 720.
Molybdenum Corp. of America, Pittsburgh.—Room 776.
Monarch Steel Co., Indianapolis, Ind.—Room 959.
Motor Products Co. (Deepfreeze Div.), North Chicago, Ill.—Room 782.
McGraw-Hill Publishing Co., New York.—Room 785.
Modern Press, Pittsburgh.—Room 967W.
Morrison Engineering Co., Cleveland.—Room 901.

National Engineering Co., Chicago.—Room 816.
National Industrial Pub. Co., Pittsburgh.—Room 970W.
National Machine Works, Chicago.—Room 911.
The New Jersey Zinc Sales Co., New York.—Room 864.
Nox-Rust Corp., Chicago.—Room 845.
North American Philips Co., Dobbs Ferry, N. Y.—Room 743.

Ohio Carbon Co., Cleveland.—Room 779.
Ohio Crankshaft Co., Cleveland.—Room 722.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.—Room 875.

Page Steel & Wire Div., Monessen, Pa.—Room 729.
Pangborn Corp., Hagerstown, Md.—Room 961W.
Park Chemical Co., Detroit.—Room 861.
Phillips Mfg. Co., Chicago.—Room 747.
Physicists Research Co., Ann Arbor, Mich.—Room 740.
Picker X-Ray Corp., New York, N. Y.—Rooms 715 and 716.
Pines Engineering Co., Aurora, Ill.—Room 944.
Pittsburgh Pipe Cleaner Co., Pittsburgh.—Room 904.
Precision Scientific Co., Chicago.—Room 707.
Product Engineering, New York.—Room 785.
Penton Publishing Co., Cleveland.—Room 917.

Radium Chemical Co., New York.—Room 857.
N. Ransohoff, Inc., Cincinnati.—Room 805.
Ransome Machinery Co., Dunellen, N. J.—Room 876.
Reynolds Metals Co., Louisville, Ky.—Room 907W.
Reinhold Publishing Corp., New York.—Room 758.
Riehle Testing Machine Div., East Moline, Ill.—Room 848.
Rustless Iron & Steel Corp., Baltimore, Md.—Room 804.
Joseph T. Ryerson & Son, Inc., Chicago.—Room 786.

Salkover Metal Processing Co., Chicago.—Room 730.
Savage Tool Co., Minneapolis, Minn.—Rooms 833 and 834.
George Scherr Co., New York.—Room 959W.
A. Schrader's Son, Brooklyn.—Room 741.
The Sentry Co., Foxboro, Mass.—Room 709.
Solventol Chemical Products, Inc., Detroit.—Room 938W.
Sparkler Mfg. Co., Mundelein, Ill.—Room 926W.
The Spencer Turbine Co., Hartford, Conn.—Room 748.
Sperry Products, Inc., Hoboken, N. J.—Room 844.
Standard Steel Spring Co., Coraopolis, Pa.—Room 910.
Steel, Cleveland.—Room 917.
Sterling Alloys, Inc., Woburn, Mass.—Room 906.
Stevens Grease & Oil Co., Cleveland.—Room 976W.
D. A. Stuart Oil Co., Ltd., Chicago—Room 704.
Sturgis Products Co., Sturgis, Mich.—Room 862.
Steel Publications, Pittsburgh.—Room 969W.

Tempil Corp., New York.—Room 812.
Torit Mfg. Co., St. Paul, Minn.—Room 802.
Tube Turns, Inc., Louisville, Ky.—Room 733.

Union Steel Products Co., Albion, Mich.—Room 764.
United States Stoneware Co., New York.—Room 855.
Upton Electric Furnace Div., Detroit.—Room 912.

Wall-Colmonoy Corp., Detroit.—Room 964W.
Welding Engineer, Chicago.—Room 819.
Welding Engineering Co., Milwaukee.—Room 808.
S. K. Wellman Co., Cleveland.—Room 908W.
Wells Petroleum Co., Chicago.—Room 976W.
Western Metals, Los Angeles, Calif.—Room 858.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Rooms 750, 751 and 752.
Wheelco Instruments Co., Chicago.—Room 902.
Wilson Mechanical Instrument Co., New York.—Room 746.

Steel Cartridge Cases

In appraising the metallurgical engineering achievements of recent months, Dr. Zay Jeffries, in an article in this issue, places at the top of the list the cooperation of industry in opening up its vast bank of metallurgical "know how" to competitors and non-competitors alike in solving various problems vital to the success of the war.

In another article in this "achievement issue" we present a somewhat detailed description of the manufacture of steel cartridge cases. It should be emphasized that in certain investigations in connection with this development, particularly the perfection of a suitable steel, cooperation of the steel industry and of metallurgical engineers of the War Metallurgy Committee was a prime cause of the success achieved.

Their problem was to develop a steel which, when subjected to methods very similar to those used in the processing of brass in making cartridge cases, should have the same physical properties as the brass product — a problem by no means easy to solve and one which has baffled the investigators of other nations in the past. As Colonel Turner points out, the development of this steel is the result of one of the greatest cooperative efforts in the steel industry. Had this effort failed, the whole program for the manufacture of cartridge cases from steel would not have succeeded. Cooperation by other branches of industry and by the Ordnance Department engineers were also vital factors.

We have had the valued experience of witnessing the manufacture of steel cartridge cases in a plant — one of more than 50 — where millions of the smaller ones are now being made. It is an impressive sight — more testimony to the inventive genius of American industrial engineers. After Major General Campbell, chief of ordnance, had inspected the manufacture and the firing of these steel artillery cases, he enthusiastically declared that their manufacture was one of the greatest mechanical achievements to emerge from the present war. He is right — and it is also a metallurgical achievement which frees vast amounts of copper (and zinc) for other war purposes. Those closely associated with this problem from the beginning state categorically that much has been learned about the drawing of steel and that as a result some fundamental conceptions in this field have been set aside. —E. F. C.

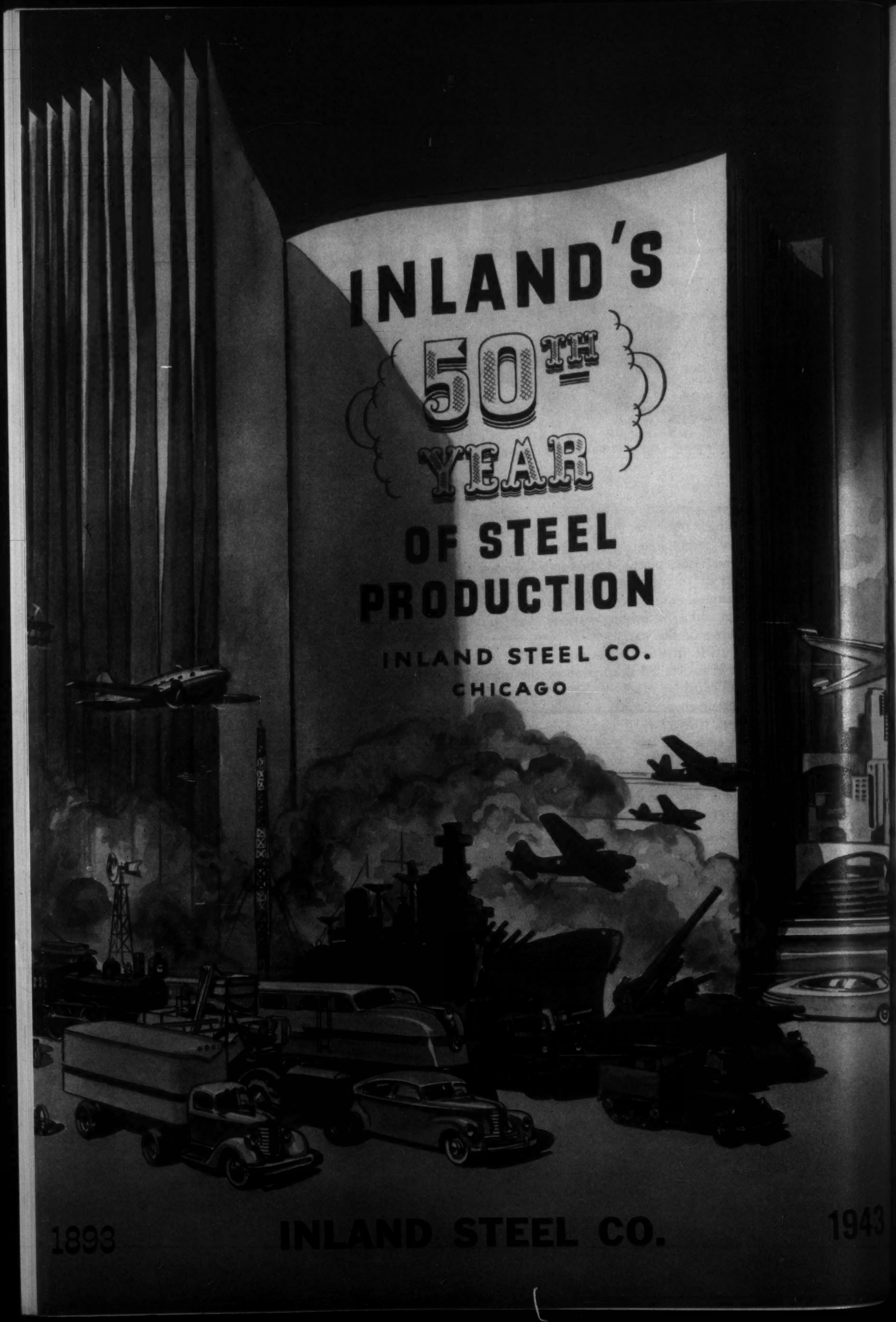
Decentralization of Industry

In taking a survey on post-war problems, results of which are published in this issue, one interesting group of answers was in response to: "Do you believe industry will continue to be decentralized as it is now, or will it drift back to old centers and populations of production? By two to one, the voters expected continued or even greater decentralization.

Unfortunately a questionnaire does not leave much room for expanding, or reasoning with, an idea. Perhaps full discussion would have brought forth the following ideas:

During the first World War, 80 per cent of war production was concentrated on the Atlantic seaboard, from Boston to Norfolk, Va. Naturally the first thought of our War Department in the current era of bombing warfare was to scatter our munitions plants.

Secondly, it became evident that many well-established centers of production, like Detroit, do not have enough housing, transportation and other facilities. Hence the load must be taken off them. Again, much freight and haulage are saved by scat-


INLAND'S
50TH
YEAR
OF STEEL
PRODUCTION
INLAND STEEL CO.
CHICAGO
1893
INLAND STEEL CO.
1943

tered industrial plants, provided raw materials are not too far distant. Labor supply can be recruited and distributed more evenly over the country and it is unnecessary for potential workers to travel several hundred miles to reach manufacturing work.

Often, too, it is well to combine rural labor with industrial occupations. There is a surplus of such labor in the winter, the food supply is ample and there is a certain ruggedness and stability of character which rural life gives.

We are inclined to agree with the majority vote in our survey that decentralization is here to stay. There are, of course, exceptions. Birmingham will remain a steel center because of the proximity of coal and iron ore. New York may continue the garment center because certain races and nationalities seek the big cities by instinct.

Promoting decentralization, too, will be the new age of transportation, what with streamlined trains, airplanes, helicopters and good roads; also the radio, which brings entertainment and fresh news to remote communities. Again, food shortages have impressed on us humans the goodness of the earth and agricultural communities. Work is most efficient where one is happiest. Perhaps the most efficient plant of the future will be one in a small population center — provided the away-from-the-city movement is genuine. Dreadful bombings of cities have not made large centers more popular either.

—H. A. K.

More Pig Iron from Fewer Furnaces

Changes in the operation of American pig iron blast furnaces — changes that border on the sensational — have taken place in the last few years. The capacity has decidedly increased but the total number of stacks has markedly declined. More pig iron is being made from fewer furnaces.

Absorbed as many are in the decided expansion of our open-hearth and electric steel ingot output, there is a natural inclination to overlook the pig iron situation. A study of the official statistics of the American Iron and Steel Institute brings to light some interesting information.

Let us take, for example, the last 30 years. On Jan. 1, 1913, there were 417 stacks (coke) with a rated annual capacity of 48,955,200 net tons or approximately 117,400 tons per furnace. At the beginning of 1943, there were only 238 furnaces with a rated annual capacity of 63,826,330 tons or about 268,177 tons per furnace. Thus with 179 less furnaces than 30 years ago, the amount of pig iron and ferroalloys possible from these is over 14,871,000 tons more than it was then. Thus, in the 30-year period there has been a decline of 179 in the number of stacks but an increase of over 150,700 tons per stack — a remarkable reversal.

An interesting sidelight in this picture is the change that has taken place in the charcoal iron blast furnace situation. Thirty years ago there were 45 charcoal blast furnaces with a rated capacity of over 766,400 net tons of charcoal pig iron per year. Now there are only 4 such furnaces in the country capable of making only 107,200 tons each year. Here too the capacity of such furnaces has expanded — from 17,000 tons per furnace in 1913 to 26,800 tons for each stack at present. The decline in this case has been much more marked than in the coke furnaces — due in large measure to less demand for the charcoal brand.

The trend in this 30-year period has been towards larger and better furnaces. Some of the furnaces making coke pig iron are producing over 1,000 tons a day or more than 365,000 tons per year. This has been made possible by improvements in design and by progress in metallurgical operating technique. The blast furnace superintendents of today are far in advance of those in the early 1900's. —E. F. C.

A Nation of Metal Experts?

An editorial in the New York *Times* stating that not all the lessons from the war are necessarily about war, points out that many people are learning for the first time that tin cans are only one per cent tin. The same thought might be expanded to include such facts as that China is the chief source of tungsten, that stainless steel contains chromium and usually nickel, that magnesium is not merely a laboratory curiosity or photographer's accessory, and so on.

In addition to educating the general public about a few random bits of metal lore, the war has widened the spread of knowledge of the fundamentals of metallurgy and its associated engineering phases. Basic training programs in this subject, with thousands of enrollees, are too perfunctory to turn out metallurgical engineers, but the knowledge imparted is sure to have some effect upon the metal industries and upon society in general. When more heat treaters know not only what to do but why they do it, when more purchasing agents know the essential properties of the metals they are asked to order—yes, even when more housewives can judge metal articles for the home upon some basis other than the salesman's claims—the metal industries are sure to benefit.

We might even hope that, if and when the next war rolls around, there may be fewer bright boys and girls in Washington making pronouncements about brass mines and the silver content of nickel silver.

—K. R.

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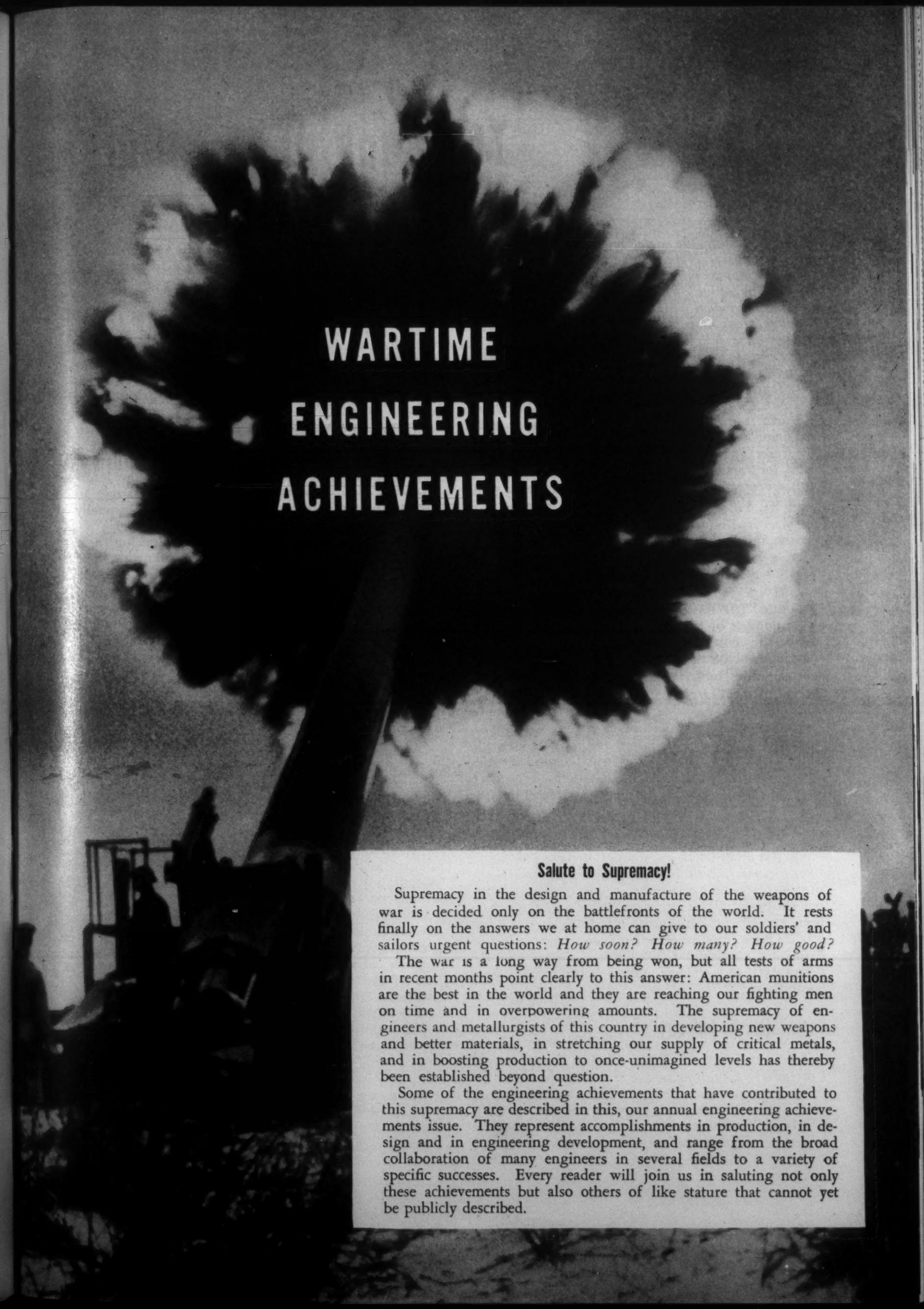


WARTIME ENGINEERING ACHIEVEMENTS

Salute to Supremacy!

Supremacy in the design and manufacture of the weapons of war is decided only on the battlefronts of the world. It rests finally on the answers we at home can give to our soldiers' and sailors urgent questions: *How soon? How many? How good?*

The war is a long way from being won, but all tests of arms in recent months point clearly to this answer: American munitions are the best in the world and they are reaching our fighting men on time and in overpowering amounts. The supremacy of engineers and metallurgists of this country in developing new weapons and better materials, in stretching our supply of critical metals, and in boosting production to once-unimagined levels has thereby been established beyond question.

Some of the engineering achievements that have contributed to this supremacy are described in this, our annual engineering achievements issue. They represent accomplishments in production, in design and in engineering development, and range from the broad collaboration of many engineers in several fields to a variety of specific successes. Every reader will join us in saluting not only these achievements but also others of like stature that cannot yet be publicly described.

WARTIME ENGINEERING ACHIEVEMENTS

The Bank of Metallurgical

In appraising the metal industries' many wartime engineering achievements for their relative values as contributions to victory, one is struck by the breadth and "cooperative" nature of many. Countless successful individual programs, such as those for magnesium production, tin conservation and steel cartridge cases, each involved so many companies and engineers that no one can be singled out as exclusively responsible for the success finally achieved. Dr. Jeffries gives voice to this when he declares that the No. 1 engineering achievement in the metallurgical field is actually the astonishing sharing of technical knowledge and experience on a variety of subjects by scores of companies and laboratories, without regard for competitive factors or postwar position. To this achievement in a most important segment of our field we join him in paying grateful tribute.

—The Editors

BY ZAY JEFFRIES

DURING THE PAST FEW MONTHS I have been asked a number of times to name what I considered to be the most important metallurgical engineering development of the war. It would be hazardous in normal times to try to answer this query but, in a period of metallurgical and engineering miracles like the present, it is doubly so.

Some of these miracles cannot yet be disclosed, but a sufficient number are known to indicate the difficulty of making a choice. One is tempted to select the seven-fold expansion in aluminum; or perhaps the hundred-fold expansion in magnesium is even more important. Again, the manner in which the alloy steels have been multiplied may be a still greater achievement.

On the other hand, should any of these rate higher than the vast substitution program carried out by industries, large and small, throughout the land? Without this substitution program there would not have been enough of the scarcer metals to carry on the war. Other important developments, like induction hardening, high-speed machining, special die developments and aircraft engine bearings, also must be appraised.

Cooperation by Industry

After carefully considering these and many others, I decided to give none of the specific technologic developments first place. While I do not know about many things that have been done, and any choice is merely one man's opinion, I believe that *the most important metallurgical engineering development of the war is the opening up by industry of its great bank of metallurgical "know how," to competitors and non-competitors alike, with little regard for post-war consequences.*

In World War I the "know how" was used to help interpret results and to contribute generally purchase of the owners' products or services. Much of this has also been done in World War II. Something different and new for America, however, has also happened. Not only have industries shared their "know how" with competitors and potential post-war competitors, but they have opened their archives of research information to help solve war problems. Much of this information is literally part of their post-war capital. In addition to the information, they have made their experts available to help interpret results and to contribute generally toward the war effort.

There has been no single key for unlocking these banks of metallurgical "know how." Sometimes one company helps another; sometimes industry helps the Army or Navy; or sometimes the information is cleared through a special committee acting for a government agency like the Army, Navy, War Production Board or the Office of Scientific Research and Development. Many problems have been solved quickly and satisfactorily by combining the information gained from several sources. Experience or laboratory information can be found somewhere in America on most of the problems that arise. Usually, the "know how" is found in the expected places, but sometimes it is found in the most unexpected places. The significant thing is, however, that no matter where it is found, the owners seem glad to have it used to help win the war.

The War Metallurgy Committee an Example

Typical examples of this continual depositing and withdrawal from the "know-how" bank are presented by several projects of the War Metallurgy Committee. The advisory services of the committee are of two types—(1) the formation of special committees of metallurgical organizations to give immediate advice and assistance on a particular problem of the moment, and (2) the gathering of all available information from the country's experts and laboratories in the consideration of new processes, substitutions, conservation, etc. The committee thus serves to bring the country's metallurgical engineering experts into sharp focus on an immediate problem.

There are in addition about 100 specific research projects now being handled by the committee, either for the War Production Board or National Defense Research Committee. These projects include several

Engineering "Know-How"

in such fields as aircraft materials, armor plate, heat-resistant alloys, alumina production, magnesium production, steel processes, conservation and substitution of metals, and others. About 50 individual research laboratories are collaborating in these projects, and they have the on-the-spot cooperation of technical societies and other groups as the need arises.

Some of the units of the Advisory Committee on Metals and Minerals are virtual monuments to the kind of technological knowledge-sharing by which democracies win wars. For example, in addition to some 57 reports on manganese, chromium, vanadium and related subjects, an outstanding contribution of the Ferroalloys and Ferrous Minerals group has been the development, in cooperation with WPB, of a program for the utilization of domestic manganese ores and for the conservation of manganese in the steel industry. The Conservation and Substitution Group has submitted more than 75 reports covering all the important metals; especially noteworthy achievements of this group were the programs for producing magnesium by the ferrosilicon process, for the production of alumina from high-silica bauxites and clays, for the conservation of copper by using silver bus bars and for the widespread substitution of low-tin or tinless solders for conventional high-tin materials.

Thousands of men and hundreds of organizations have in some way contributed of their time and knowledge without fee or cost to anyone but themselves so that these programs might be carried forth. As a result of this exchange of information the consumption of critical materials has been reduced, products have been improved, production has been increased, man-power conserved and money saved. More important than these for war, *time* has been saved which means ultimately a saving in human life. These results are beyond appraisal. Because of this great contribution, it seems to me that this development is a proper candidate for first place.

Having reached this conclusion, I was surprised at the inferences some of the questioners drew from it. They asked if this conclusion did not point to the desirability of socialized industrial research in peace time as a means of expanding our peace time economy.

For what it may be worth, here is my answer. During the past 150 years democracies have proved to be the best peace time governments. In 1914-

Manganese was one of our most critical materials at the start of the war, yet pooled knowledge and cooperative conservation averted a crippling shortage. Here we see workers throwing ferromanganese into an open hearth furnace toward the end of a heat. (Courtesy United States Steel Corp.)

Much alloy development is carried out with the help of small coreless induction furnaces like the Ajax unit shown here. (Courtesy Jones & Laughlin Steel Corp.)

1918 they proved to be strongest in war. Notwithstanding the creation of war governments in certain countries and the charge that democracies were soft and decadent, they are proving themselves strongest in the war of 1939-194?. If democracies are strongest in peace and in war, they are strongest—period. We should not, therefore, experiment with anything that would destroy democracy.

Man-Power, Money, and "Know-How"

It is not accidental that a good democracy is strong in war. Assuming a reasonable supply of raw materials, wars are won by man-power, money and "know-how." No one questions the ability of our man-power on the production and technological fronts. The schooling, the games, the farm and ranch life, the driving of automobiles, the making of radios and a thousand and one other peace time activities of the young people in this country provide versatile army and navy personnel. Couple with these the fact that they fight to preserve their freedom, and they are well-nigh invincible on the battle-front. They might not fight so well if they did not feel they would have a democracy to come back to. Our peace time operations, therefore, always produce a wonderful bank of man-power for both the home and the battle-fronts on which to draw, if necessary, to win a war.

We implement war by drawing on our bank of money which also is an accumulation of peace time. Although a long and expensive war may strain our money bank, this bank is so flexible that what is not drawn from past accumulations is drawn from expected future accumulations. Our democratic system has found a way to draw on both reserves. In all cases it is money in which the people have confidence that takes care of the millions of exchanges of goods and services incident to waging war.

We have now found by experience that our democratic system operating in peace time is continuously accumulating a bank of war "know-how." The bank is rich enough to beat nations concentrating on war preparations. There is here no thought of minimizing the most important military developments made by and for the Army and the Navy between the last two wars. Still more should have been done, as is now evident, and it is to be hoped that more and

bolder military research will be done after this war. The industrial by-products of such research can be made available, indiscriminately, to industry; and the military by-products of industrial research must be made available for the military arms of our government.

Military research, however, cannot create all the "know-how" needed to win a modern war. Experience gained in making automobiles, radios and refrigerators by the millions constitutes an invaluable part of the war "know-how." Such experience can be translated into mass production of guns and other implements of war. There is inertia in converting from peace to war production, but, once the conversion is made, equipment and methods are modern, the product is up to date and the quantities are overwhelming.

Even the implements of war are not developed solely by military research. The greatest modern war implement is the airplane. It was not invented through military research. When the Wright brothers invented the airplane early in the twentieth century there was much specific military research going on in various parts of the world. It remained, however, for our system of private enterprise to give birth to this greatest of all implements of war. And so it is with much of the most valuable military equipment. Our system of private enterprise may be expected to continue to make such contributions even in peace time.

In the fields of medicine and agriculture there is much less competition for sheer existence than in industry. Partly because of this, there is a greater tendency toward socialized research in these fields than in industry. But even the developments in these fields would seem barren if it were not for the contributions of private enterprise.

Research—Life Blood of Industry

Industrial research is the life blood of industry. It has become part and parcel of our system of private enterprise. This is a competitive system. It is a system which rewards successful effort. It encourages venture capital. It provides jobs for labor, markets for inventions, and opportunities for individuals to utilize their talents and live a life of freedom. It provides the arena for the competition of the ideas of millions of people in such a way that unsound ideas fall and sound ones are proved and made available for progress. Industrial research cannot be dissociated from industry without destroying competitive industry and, in turn, our system of private enterprise which is the essence of democracy.

In war time industry is not competing with other industry as a major activity. The whole nation is competing with other nations for the very survival of our government. Public acceptance and sales problems are secondary to winning the war. Industries will not be able to sell battleships, bombers, tanks and cannon to the public after the war.

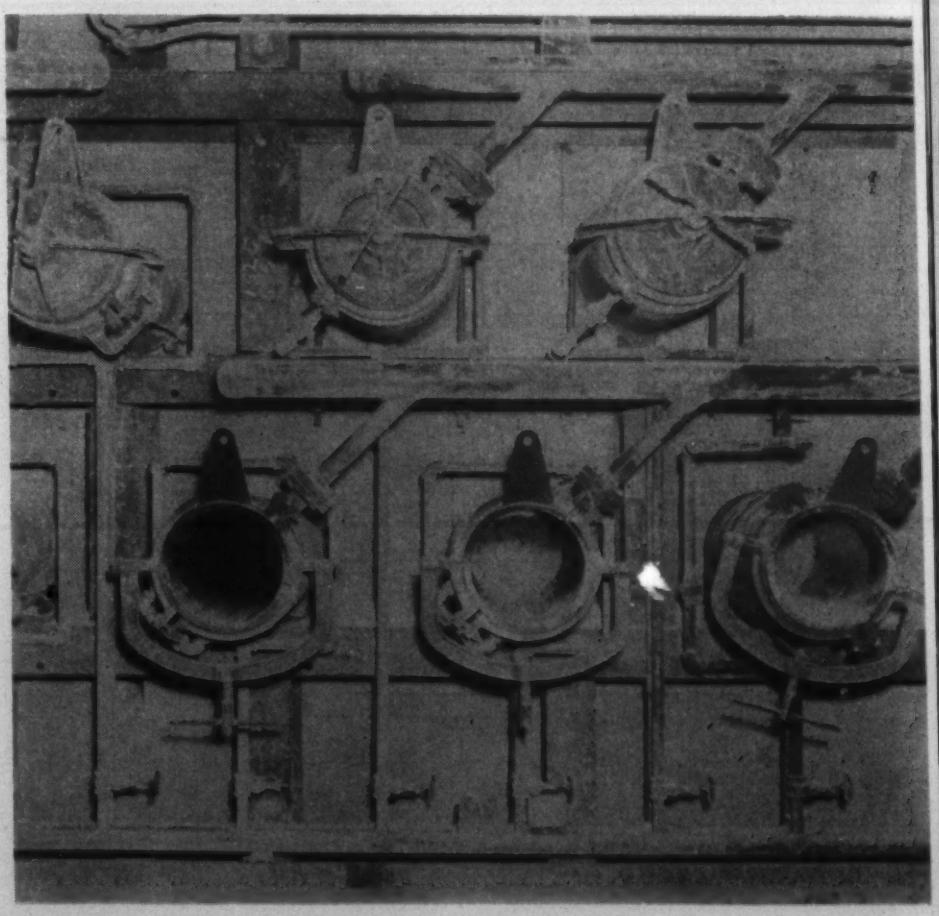
It does make sense, therefore, for industry to open its "know-how" archives to win the war, without doing so in peace time. When peace comes, we shall find industry competing not only with other industry in this country, but with industries in other countries. Proprietary use of their "know-how" will then be necessary for their economic health. In general, proprietary "know-how" will be necessary to encourage the use of venture capital without which our economy will decline.

Private Enterprise Preferred

It is my belief that this bank of "know-how" will always be greater and more up to date under our system of private enterprise than under any other system—even a military regime. We should so operate in peace time that the bank of "know-how" has the most and best reserves. We should therefore preserve our system of private enterprise and, in order to do so, we must not socialize industrial research. Socialized industrial research would weaken both our peace and our war economies. Industrial research by private enterprise does become available for war purposes in a crisis as fully as if it were socialized—and it yields better "know-how" and more of it.

Thus, the democratic system, as a result of great peace time effectiveness, inexorably accumulates, in its man power, money and "know-how" banks, the best war reserves ever known on this earth.

American and Canadian engineers cooperated in the development of the ferrosilicon process for producing metallic magnesium by heating calcined dolomitic limestone with ferrosilicon in a vacuum. Here are shown the ports from which the retorts are tapped in one installation. (Courtesy Ford Motor Co.)



WARTIME ENGINEERING ACHIEVEMENTS

Wartime production of the industries that produce metals and of the foundries has not involved the "conversion" to the manufacture of new and strange products that characterizes the metal-consuming-industries. Production methods have remained basically the same, too, for each plant, but there have been virtual revolutions in expanding the output, both of whole industries and of individual plants. Mr. Cone reviews the most outstanding of these, and also hints at some of the post-war problems they may pose.
—The Editors

Achievements in Metal Production

By EDWIN F. CONE

IN THE METAL PRODUCING FIELD there have been several achievements of outstanding importance in recent months. This is particularly true of the steel, aluminum and magnesium industries. Expansion of plant equipment and of production has been constant until total output has reached not only record but in some cases astounding figures.

It is not the object of this discussion to burden the reader with statistical data but only to briefly paint in broad outline the general picture.

Steel Ingot Output and Capacity

The chief aim of the American steel industry, ever since the war clouds began to darken the horizon before the United States actually entered the war, has been to make enough steel to insure adequate defense and to hasten the day of victory. This aim has been definitely realized. Each year since 1939 both the capacity and the production have expanded.

In the first 7 months of this year American steel furnaces have turned out more steel than in any previous similar period on record. According to the official data of the American Iron and Steel Institute, our steel output since the fall of France has reached "the amazing total of almost 259,000,000 net tons."

Due to the series of coal strikes early this year, the output in May and June was cut several hundred thousand tons, but despite this handicap it is predicted that, at the rate of output thus far, the production this year will exceed the 86,000,000 tons for 1942 by close to 4,000,000. This is again a new record.

A 1943 total of 90,000,000 tons would be nearly 80 per cent larger than the best annual production in World War I and would probably account for more than half of all the steel made in the whole world this year.

This splendid achievement of our steel industry has been accomplished together with a marked expansion in capacity—a difficult task when equipment was and is being pushed to the maximum output.

Back in 1940 current talk in Government circles was to the effect that our steel capacity would have to be increased 10,000,000 tons—to meet the needs of a possible global war. During the last 3 yrs. total annual capacity has been expanded by nearly 10,000,000 tons, says the Institute. Capacity as of July 1, this year was 90,881,000 tons per year. On completion of the present program, the total will appromate 96,000,000 tons.

This goal was scheduled to be reached by July 1, this year, but there have been various unavoidable delays. But a substantial proportion of this increase has been accomplished within the last year, though parts of the program will not be completed until some time next year.

Electric Furnace and Alloy Steel

One of the outstanding developments of the recent expansion in the steel industry has been and still is the increase in electric steel furnace capacity. New equipment has been installed this year to supplement the capacity as of Jan. 1, 1943, by nearly 400,000 tons, bringing the rated capacity on July 1, at about 4,936,000 tons a year. The extent of the growth of the electric furnace industry may be judged by the fact that capacity is now more than 2½ times that available in 1940.

New records in electric steel production are being made. In August, this year, over 407,200 tons were made by the industry, a total not equaled before or since for any one month. This may be exceeded before the end of the year—new capacity is gradually coming in. Present prospects are that the year's total output will exceed 4,750,000 tons or possibly nearly 3 times that in 1940.

One of the features of the progress in the electric steel industry has been the erection of large plants using the triplexing process. Claimed to be the largest electric steel plant in the world, the new plant of the Republic Steel Corp. in Chicago uses hot blast

furnace metal in the open-hearths and this is converted into high-grade alloy steels in the electrics.

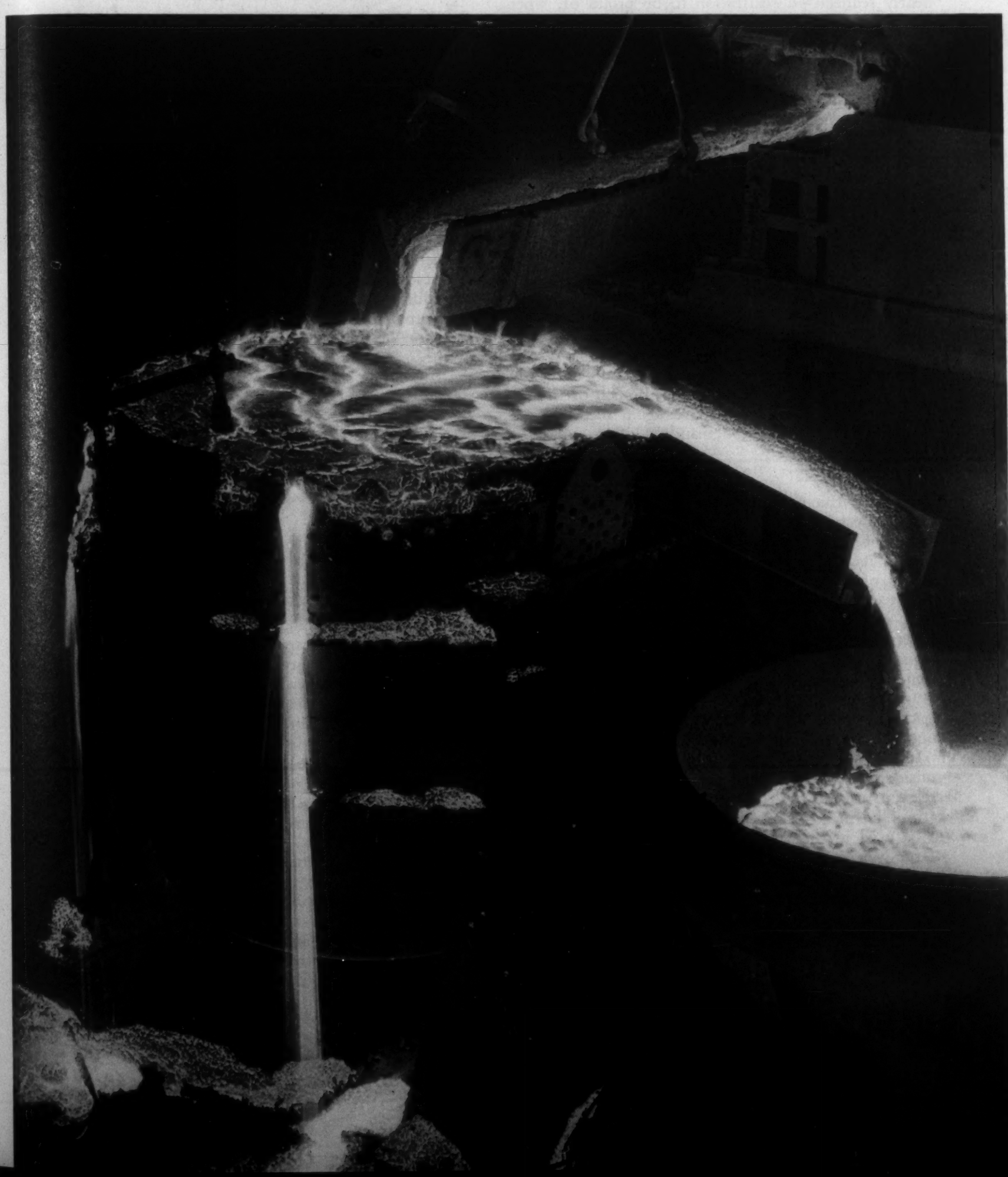
Another plant is blowing hot cupola iron in side-blow converters. This product is converted into finished steel in a battery of electric furnaces. In a new foundry in the Ford plant a similar installation is producing steel castings.

The advantage of a duplexing or triplexing technique over the cold charge process is obvious—greatly increased output in the same period of time.

The principal function of the electric furnace is the production of high-grade alloy steels. Demand for this grade, particularly for aircraft is increasing rapidly, and is of course the cause of the increased capacity and output.

A new total in production will be recorded this year, considerably above the record 11,500,000 tons made in 1942. A contributing factor in this has been the expanding use of the N.E., or National Emergency, steels which have been and are growing

Tapping a large heat of steel from an open-hearth furnace. As the molten steel fills the ladle, the slag follows and some of it overflows into the slag ladle. (Courtesy: United States Steel Corp.)



in favor. They are a determining agent in the conservation of strategic and scarce alloying elements.

Pig Iron and Steel Plates

Another achievement of the American iron and steel industry is the substantial augmenting of the blast furnace capacity of the country. As of July 1, this year, the total is rated at 64,500,000 tons per year or 500,000 tons above the first of this year and 9,000,000 tons above the capacity in 1940.

Thus, as in steel, the 10,000,000-ton increase asked for by the Government about 3 yrs. ago, has been nearly realized—a realization to be proud of, when full-scale operation of existing stacks and difficulty in securing new equipment are taken into consideration.

This cursory review of achievements of the American steel industry would not be complete if some notice were not taken of the steel plate situation.

Demand for steel plates for merchant and warships has been and still is so insistent that the plate producing capacity of the country is strained to the limit to supply the need. Only recently was the 1942 output made public by the Institute—about 11,800,000 net tons.

A feature of this record is that 37.6 per cent of this total was produced on strip mills converted to plate production.

This year this incessant demand has continued and will be likely to extend into 1944. Over 7,450,000 tons of plates had been produced to Aug. 1, this year, which indicates a new total for 1943 of nearly 13,000,000 tons. Thus in another branch of the industry, the steel producers have again met and are measuring up to the war demands.

The Light Metals

Probably the most sensational achievement in the metal industries has been the expansion in output of the light metals—aluminum and magnesium. It reaches its culmination this year. Reliably accurate figures of the output or the capacity at the end of this year are not obtainable. But, as Dr. Zay Jeffries, in his article on other pages of this issue, indicates, in enumerating some of the metallurgical engineering achievements of today, the expansion has been about 7-fold in the case of aluminum and about 100-fold in magnesium—of course over prewar or peacetime volume. This refers to the metals in the ingot or crude form.

In reviewing the expansion in these two industries, consideration must also be given to the very large increase in rolling mill and other equipment for fabricating the metals and their alloys into the products to be used in the war effort. In this the expansion of pre-war equipment and the building of new plants has been tremendous.

In the manufacture of aluminum from its raw material, no really new methods have been put into operation. The metal is still made from bauxite—the dream of its production from clays and similar materials has not yet been commercially realized. Probably some day it will.

In the case of magnesium, however, the development of new processes of obtaining the metal has been striking. Besides the standard method of the Dow Chemical Co. of obtaining magnesium from salt brines in Michigan, the enterprising effort of the same company to recover magnesium from sea water has been a commercial success with large quantities now being produced by this highly interesting and sensational metallurgical engineering development.

Outstanding, however, has been the development and perfection of the production of magnesium from dolomite by the ferrosilicon process. Several companies have been organized and a number of plants have been built, using this process in some form, so that by the end of this year the commercial production by this method will have reached very large proportions. Several articles describing the details of the process have been published.

Light Metals After the War

The post-war condition in these two industries gives rise to some rather serious speculation. Jesse Jones, chairman of the R.F.C., in a recent statement is reported to have said that after the war the Government will own about 92 per cent of the country's magnesium capacity and more than 50 per cent of the aluminum. This ownership will constitute a vital problem in post-war economy. It will be possible for the Government to smother private industry in the manufacture of magnesium and to dominate the aluminum industry. These situations, he declared, will require wisdom and fairness by the Government if private investments are not destroyed. He added that the Government has built and owns 45 plants for the fabrication of aluminum.

Here is an opportunity for economists and industrialists, inside and outside Congress, to do some serious thinking.

Other Industries

Only casual mention can be made here of the splendid records made in certain other industries—copper, lead, zinc and the foundries. The copper, lead and zinc producers have kept up with the war effort under difficult circumstances. Demand for copper has been particularly heavy with serious apprehensions at times as to an adequate supply. The growing production of steel cartridge cases, described in some detail on other pages, is gradually relieving the overall situation as is also the return of some soldiers to the mines.

The foundries—steel, malleable, gray iron and nonferrous—have not been as hard pressed as have the steel ingot producers. Demand for their castings have not been much beyond the capacity of the industries, except probably in the case of magnesium. Probably the heaviest war demand has been on the products of the steel foundry industry—particularly for cast armor plate and other castings used in the war effort. In this the steel casting manufacturers have performed a highly commendable task.

WARTIME ENGINEERING ACHIEVEMENTS

The Manufacture of Steel Cartridge Cases

Representative steel discs and the cartridge cases made from them. They are (right to left) the 20, the 37 M 1, the 37 M 16, the 40 and the 57-mm. steel discs and cartridge cases.

By LT. COLONEL H. R. TURNER

Deputy-Chairman, Cartridge Case Industry Committee, Cincinnati

Called by Major General Campbell one of the greatest mechanical achievements to emerge from the present war, the successful production of artillery cartridge cases of steel by American manufacturers is indeed a top-ranking engineering accomplishment. Traditionally made of brass, the cartridge case presented a number of imposing obstacles to fabrication in steel, but these were overcome by the untiring and unselfish cooperation of a large group of shell case manufacturers, steel mills, equipment suppliers and Ordnance Department experts. The teamwork in this entire program is exactly the sort of thing to which Dr. Jeffries pays tribute in his article in this issue.

More than 50 companies are now making steel cartridge cases in various sizes. This article, whose author was in the center of the development from its beginning, gives the engineering background of the problem and describes in permissible detail the practice of the Corcoran-Brown Lamp Div. of the Auto-Lite Co. in producing 20-mm. cases.

—The Editors

THE TIME HAS NOW COME when it may be said that the impossible has been accomplished—the commercial manufacture of steel cartridge cases. It is a great tribute to American industry, to American ingenuity and persistence that that task, which appeared to be an impossible one, has now become essentially a production job.

Since the early days of World War I, the ordnance engineers of practically all the nations of the world have attempted periodically to manufacture artillery cartridge cases from steel. When the terrific impact of the present World War appeared, with its drain on the natural resources of the United States, it developed that it was practically a necessity that the copper, normally used in making cartridge cases for artillery, should be released for other more important applications. The natural consequence was that the problem of the steel cartridge case had to be solved.

This problem was put up, in the early summer of 1941, to Ordnance engineers and to American industry. There were no illusions on the part of anyone but that the task was a tremendous one—almost impossible, so far as research into the history of previous attempts could reveal. As already indicated the problem has been solved and it is the object of this article to make public as many of the details as can now be revealed.

Cartridge cases have always been made from brass. This is quite easily understood when it is recognized that brass is a material that has well-known properties as to workability and that has optimum characteristics for the task it is to perform. In the development of the steel cartridge case, it was early concluded that the rather obvious path to follow, so far as possible, was that developed in the production of brass cartridge cases. But steel is a material that does not readily respond to the same treatments as brass and this gave rise to some difficult problems.

Following much discouraging work, it was discovered that the heading process in crushing a thick section of brass into the head of a cartridge case absolutely destroyed a similar piece for a steel cartridge case. Several processes were developed to eliminate this source of difficulty.

The Steel Cup and Its Design

A cup of steel was finally designed of such shape and contour that, when finished without the brute

The steel disc and the cup made from it which form the basis of the 20-mm. steel cartridge case.

force method applied to brass, would produce the required shape in the head of the case. It was found that the design of the cups must be such as to include enough thickness in the base section to provide an annular ring about this base section and to supply the material for the extractor flanges and the thin tapered side walls which ultimately become the walls of the cartridge case.

Much has been said about the method to be used in the manufacture of the cup—whether it should be made from a disc cut from steel plate and formed cold, or made from a slug, cut from a bar or billet of steel and forged into shape.

All things being equal as to design of tools, chemistry of material, and kind of process, it has been

One of several banks of hydraulic presses in the plant of the Corcoran-Brown company used in drawing the steel cartridge cases of various diameters. (Courtesy: Hydraulic Press Mfg. Co., Mount Gilead, Ohio.)

found that it makes no difference whatsoever which process is used in making the cups. The important things are that the chemistry of the steel is right, that the physical shape is correct, and that the process controls the flow of the materials so that the pattern developed is inherently sound.

It is a comparatively simple task to draw a steel cartridge case if one starts with a cup of the characteristics outlined in the preceding paragraphs. The same presses used in drawing and making brass cartridge cases can be used for the steel cases and this is the case in many of the plants formerly producing brass but now making steel cases.

Dies and Cutting Tools

As to the draw dies, it is highly important that they be made of tungsten-carbide rather than of steel —the former is particularly suited to the job and the life realized is entirely satisfactory. Lubrication is an extremely important matter but almost any lubricant can be made to work.

As to the design of both the punches and the dies, the design for the steel cases is practically identical with that used for the brass cases—the drawing is essentially the same but the tonnage pressures required are somewhat higher.

For forming the accurate shapes at the head of the case, for cutting and squaring off the draw pieces, the cutting tools used conform to the same differentials that are required in all machine operations when comparing the two materials, brass and steel. Cutting speeds and feeds are somewhat slower for steel and cutter grinding is different, but the same fundamental principles apply.

Physical Properties by Cold Work

When it comes to a consideration of the physical properties of the steel in the cases, those required can be obtained by two methods: Quench and draw, or cold work. It is realized of course that quenching and drawing such very thin and irregular sections is by no means a simple task but in a few instances it is being used with highly successful results by means of methods developed during the course of the project.

The attainment of physical properties by cold work was almost entirely unexplored, but it has been found that with an 0.25 per cent C steel, herein later described, it is possible to secure yield strengths by this method as high as 130,000 lbs. per sq. in. with an elongation up to 5 per cent.

In the selection of a suitable steel for the cartridge case, several technological problems were encountered. In the early stages of the program, there was a deep-seated opinion among those familiar with the drawing of steel that a steel with more than 0.15 per cent C would be very difficult to manipulate.

Unfortunately, however, except for the use of the most drastic forms of heat treatment, such a steel would not produce the physical requirements needed to make satisfactory cartridge cases.

Some of the reasons for this statement are that, in spite of its simple appearance, a cartridge case is far from simple as a device. Its purpose in artillery ammunition is complex. It provides a container for the propellent powder. It is a support for the primer that ignites the propellent, thus forming the gases that move the projectile. It is a support and carrying medium for the projectile.

One of the hydraulic presses used in drawing the steel cartridge case. The first draw of the cups for the 37-mm. case is being carried on here. (Courtesy: Hydraulic Press Mfg. Co.)

One of the gas annealing furnaces for treating the steel cartridge cases in various stages of the drawing operations.

One of the machining operations on the 20-mm. case. The head is being turned on a New Britain Gridley machine.

In addition to these comparatively simple functions, the case also acts as a valve operating at an extraordinary rate of speed to seal off pressures of very high magnitude—a period of time of about one thousandth of a second and of pressures as high as 60,000 lbs. per sq. in. These properties range in the neighborhood of 110,000 lbs. per sq. in. yield strength.

The Steel Used

It was finally determined, after long study and experimentation, that the steel to be used should be a modification of SAE 1025. The steel now used, as modified and furnished by the steel companies, has the following composition:

	Per Cent
Carbon	0.22 to 0.32
Manganese	0.45 to 0.75
Phosphorus	0.040 max.
Sulphur	0.045 max.
Silicon	0.10 max.

In addition, the steel must be extraordinarily clean and made in big-end-up hot-top molds. It can be either an open-hearth or electric furnace product. Experience has demonstrated that it must be aluminum-killed and, to put it in satisfactory condition for processing, it must be spheroidized.

The surface of the steel has presented a real problem. Some mills had to make rather elaborate changes in the delivery end of the rolling equipment. The necessity of cross rolling the steel has been a matter of controversy. While it is true that 100 per cent cross rolled steel would be advantageous, it has been found to be by no means necessary. More than any other one thing, cleanliness is important.

It should be stated here that the manufacture of such a steel proved to be a real challenge to the ingenuity and ability of the country's steel producers who have devoted their time, ability and money most unselfishly in one of the greatest cooperative efforts in the steel industry. And the results to date have been highly satisfactory—a steel has been developed that, after cold drawing and other treatment, has virtually the same physical and other properties es-

Tapering the ends of the 20-mm. steel cases on a Bliss horizontal press.

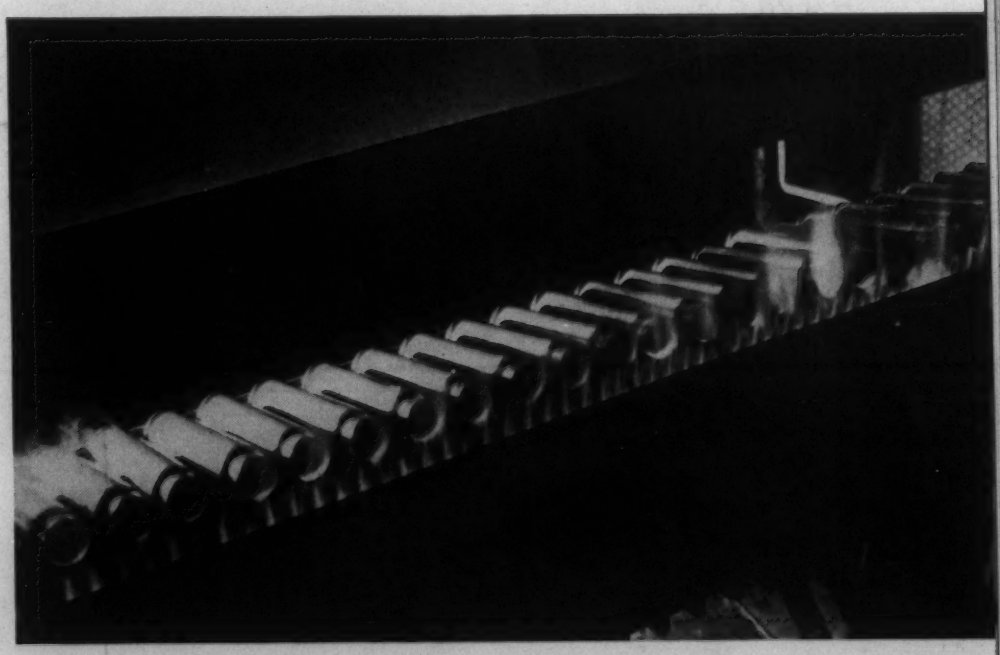
sential in the manufacture of brass cartridge cases.

In the numerous plants that are now making steel cartridge cases, one general processing procedure is used. There are modifications of this procedure in some plants but they are generally of a minor nature. To furnish a clear picture of the process in general, the practice of one plant can be discussed.

In this article, the methods used by the Corcoran-Brown Lamp Div. of the Auto-Lite Co. in Cincinnati are described. It will be remembered that most of the early experiments, trials and headaches in solving the steel cartridge case problems were experienced by this company and its zealous, indomitable staff, working in conjunction with the Army Ordnance and the Frankford Arsenal.

The 20-mm. Steel Cases

At this plant millions of steel cartridge cases—20, 37 and 40-mm., etc.—are being made each month. Typical of these is the 20-mm., some of the details of its processing being as follows:



The mouths of the steel cases, after tapering and trimming, are annealed in a gas flame.

All producers of steel cases must start with a cup. The established custom is for the steel company, which makes the steel to the specifications demanded, to prepare discs of specified dimensions and ship them to the company which forms the cups.

The nearby plant of the Patterson Products Co. furnishes cups for the Corcoran-Brown company. These are stamped or drawn by a battery of suitable presses into cups for the 20-mm. and larger cases. Large quantities of these are delivered daily to the Corcoran-Brown plant.

The first step in the treatment of the 20-mm. cup is to anneal them in a gas-fired, controlled atmosphere, roller hearth continuous furnace at 1650 deg. F. The first draw of the cup on a 400-ton mechanical press follows this treatment. After washing in an alkali cleaner, the products of the first draw are again annealed as above. They are then "coated" in a dip tank containing a soap solution which acts as a lubricant, and subjected to the second drawing operation on a 200-ton mechanical press.

The products of this second drawing operation are not again annealed but are subjected to dipping in the soap solution, which again acts as a lubricant. The third drawing operation on a 200-ton press follows this. At this point it has been found necessary to wash the products in an alkali cleaner, similar to the operation after the first draw of the cups. They are then trimmed on automatic trimmers, and annealed for the third time in continuous gas or electric furnaces at 1650 deg. F.

Subjected to the usual dip in a soap solution, they are then drawn for the fourth time on a 200-ton mechanical press. After the usual coating with the soap solution, the cases are subjected to the fifth drawing on a 200-ton mechanical press. The usual washing in an alkali solution follows, after which the drawn cases are trimmed and headed on a 200-ton press to form the primer indent, followed by machining.

The tapering operation is the next step. This is preceded by an alkali wash of the machined product followed by subjection to the lubricating soap solution. The cases are then tapered on horizontal presses and subjected to a final trim on suitable equipment.

After washing again in an alkali solution, the mouths of the tapered cases are annealed in a gas flame and then stress relieved at 725 deg. F. They are then pickled in a mild solution of hydrochloric acid and suitably cleaned. This is followed by adjusting the size of the mouth and removing burrs and so forth. They are then submitted to careful inspection by a large corps of inspectors in a special department.

The Corrosion Problem

One step in the final preparation ot the steel cartridge case is the method of solving the corrosion problem—a very interesting procedure. After the cases have passed through the hands of the inspection department, they are finally dipped in a phenolic varnish solution. Carried by a conveyor from

Steel cartridge cases are tested for hardness on Rockwell machines.

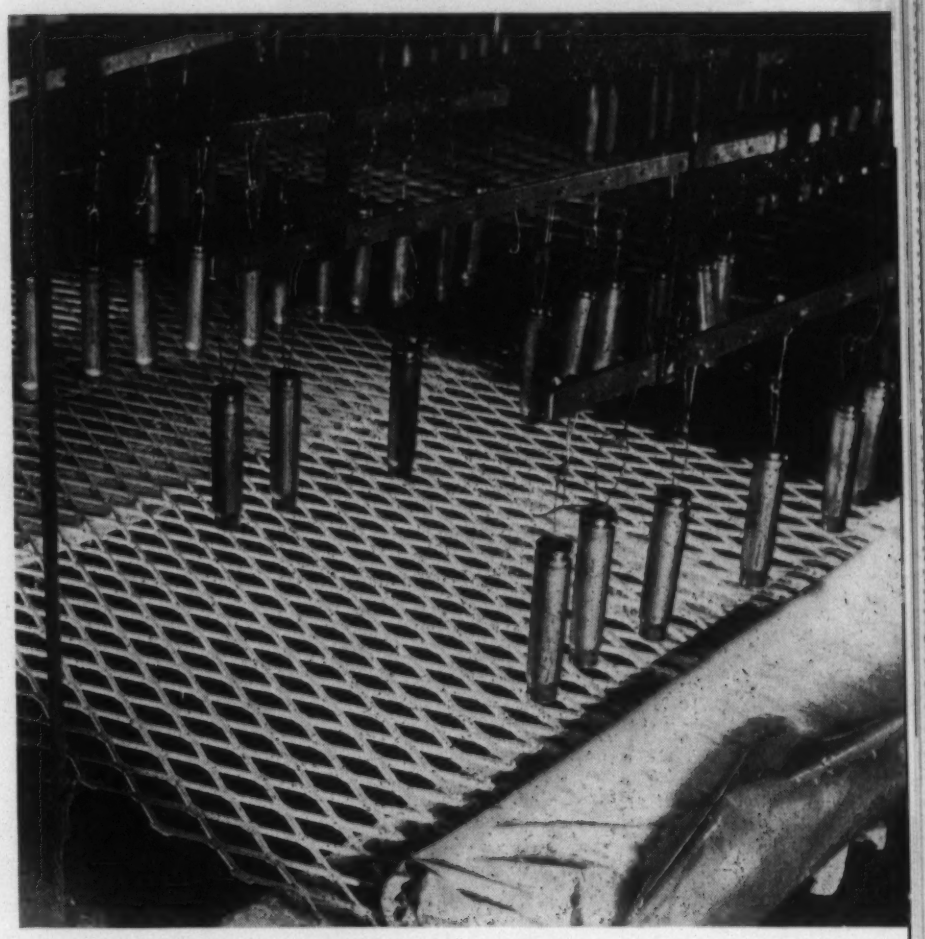
this solution, they are passed over Ransberg detearing machines which by electrostatic action remove the excess varnish. They are then baked for about 20 min. in an oven at about 350 deg. F., after which they are ready for packing and shipping.

Thus to produce a 20-mm. steel cartridge case, five drawings on mechanical presses are necessary, interspersed with three annealings between certain draws. In the production of the 37 and 40-mm. cases, annealing between each draw is necessary, due to the more severe work hardening effect. But in general the procedure in the various steps in the manufacture of the 20-mm. steel cartridge case, as here described, may be regarded as typical of other sizes.

Such, in general, is the story of the present status of the manufacture of the steel cartridge case. In the accomplishment of this task, much has been learned concerning the making and processing of steel. A steel has been developed and produced that by the cold work or drawing process attains the necessary physical properties. Also steel containing 0.32 per cent C and higher can be successfully drawn—an achievement hitherto regarded as impossible.

Just after witnessing a demonstration of the steel cartridge case at the Jefferson Proving Grounds in Indiana not long ago, Major General Levin H. Campbell, Jr., chief of ordnance, declared that the production of the steel cartridge case was one of the greatest mechanical achievements to emerge from the present war.

The 20-mm. case emerging from the varnish solution and passing over the electrostatic detearing machines.



Part of the extensive department in which the steel cartridge cases are subjected to many inspection tests.

WARTIME ENGINEERING ACHIEVEMENTS

Conservation Through th

When cheers are given for fighting comebacks in this war effort, we have three all ready for the performance of metal stampings manufacturers in restoring their stalled industry to a high war-production level through collaboration with Army Ordnance in a redesign-for-stampings program that permitted the conservation of large amounts of material, machine-time and production man-hours. A year ago we declared that "the country's idle stamping presses class as one of the major heartaches of the war-production changeover." Today we can happily state that a majority of those presses are now busy. This article reviews the achievement implicit in the latter statement, and gives several specific examples of important process conversions that resulted in large savings in time, labor, metal or money.

—The Editors

By KENNETH ROSE
Engineering Editor

THE WAR EFFORT has changed the picture of American industry tremendously, expanding some processes a thousandfold and more, while sentencing others to banishment for the duration. No branch of manufacture, however, experienced a more violent cycle than the pressed metal industry. A $277,000,000 business with 880 members in 1941, operations in 1942 had fallen to less than 25 per cent of capacity. They are now 75 to 80 per cent and still rising.

By its very nature, one might expect pressed metal fabrication to be a favored process in most peacetime mass production systems, and this was the case. The largest user by far of pressed metal parts was the automobile industry. Refrigeration came next, followed by such homely items as washing machines, incinerators, lawn mowers, ironing machines, oil burners, bicycles, mousetraps, electrical fixtures—the breath of life to pre-war American manufacturing. It needs but a glance at this list, too, to realize what happened to an industry dependent upon these articles when war production demanded all the metal available.

A few figures tell the story. The pressed steel industry has been called a child of the automobile industry. Early cars used rolled shapes, castings, forgings and wood. Modern cars are of pressed steel—frame, body, wheels, fenders. In 1941, 3,744,300 passenger cars and 1,094,261 trucks were produced, while February 1942 saw the end of production for civilian use with only 215,545 passenger cars made, and no trucks at all. The same thing happened to pressed metals' second largest customer; 3,500,000 refrigerators were made in 1941 as against about 500,000 in 1942. The lack of metal for civilian use did the same in other presswork fields.

Ordnance items were largely designed as castings, forgings, or to be machined from bar stock. It became apparent early in the production program that facilities for this type of fabrication would be swamped. Pressed metal men saw this piled-up work on one hand and their own idle plants on the other, and determined to do something about it.

A number of ordnance parts were redesigned by G. E. Whitlock, president of Mullens Mfg. Co, so as to permit fabrication by press methods, and submitted to the Office of the Chief of Ordnance in Washington. They were enthusiastically received. To facilitate this redesign of other pieces, the Army Ordnance officially established, in May 1942, a Suggestion and Conversion Section in its Washington office and in the 13 Ordnance District offices, while the stamped metal fabricators formed the Pressed Metal Institute to assist in listing equipment available and in subcontracting.

The Field for Stampings

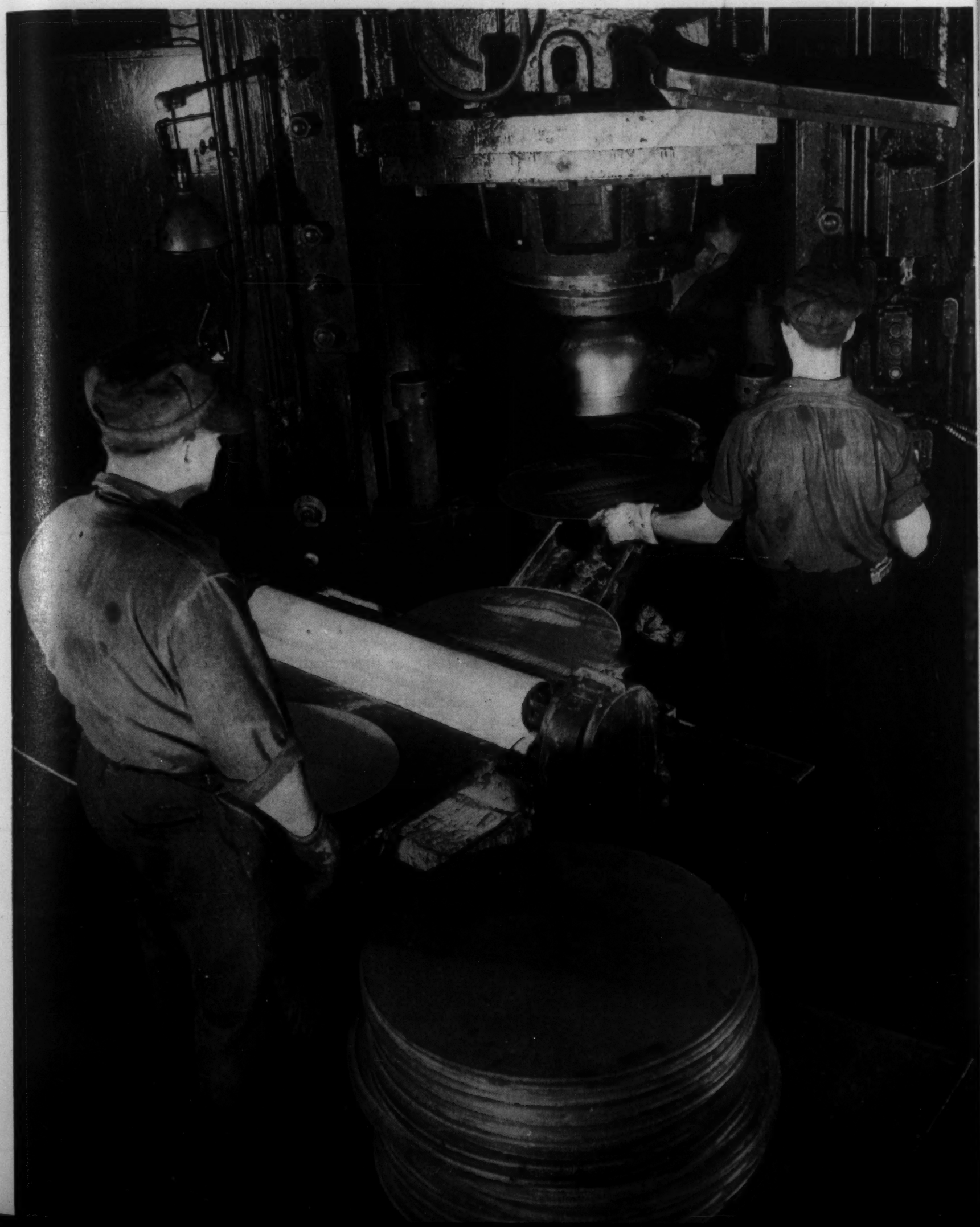
Metal pressworking operations offer a number of advantages over casting, forging or machining processes which make them peculiarly adaptable to the production of many military items. After the dies have been made, production is rapid and economical, and parts are interchangeable. The work as turned out frequently needs no machining, so that the slow cutting off of excess metal is eliminated or greatly reduced. This lessens the amount of scrap.

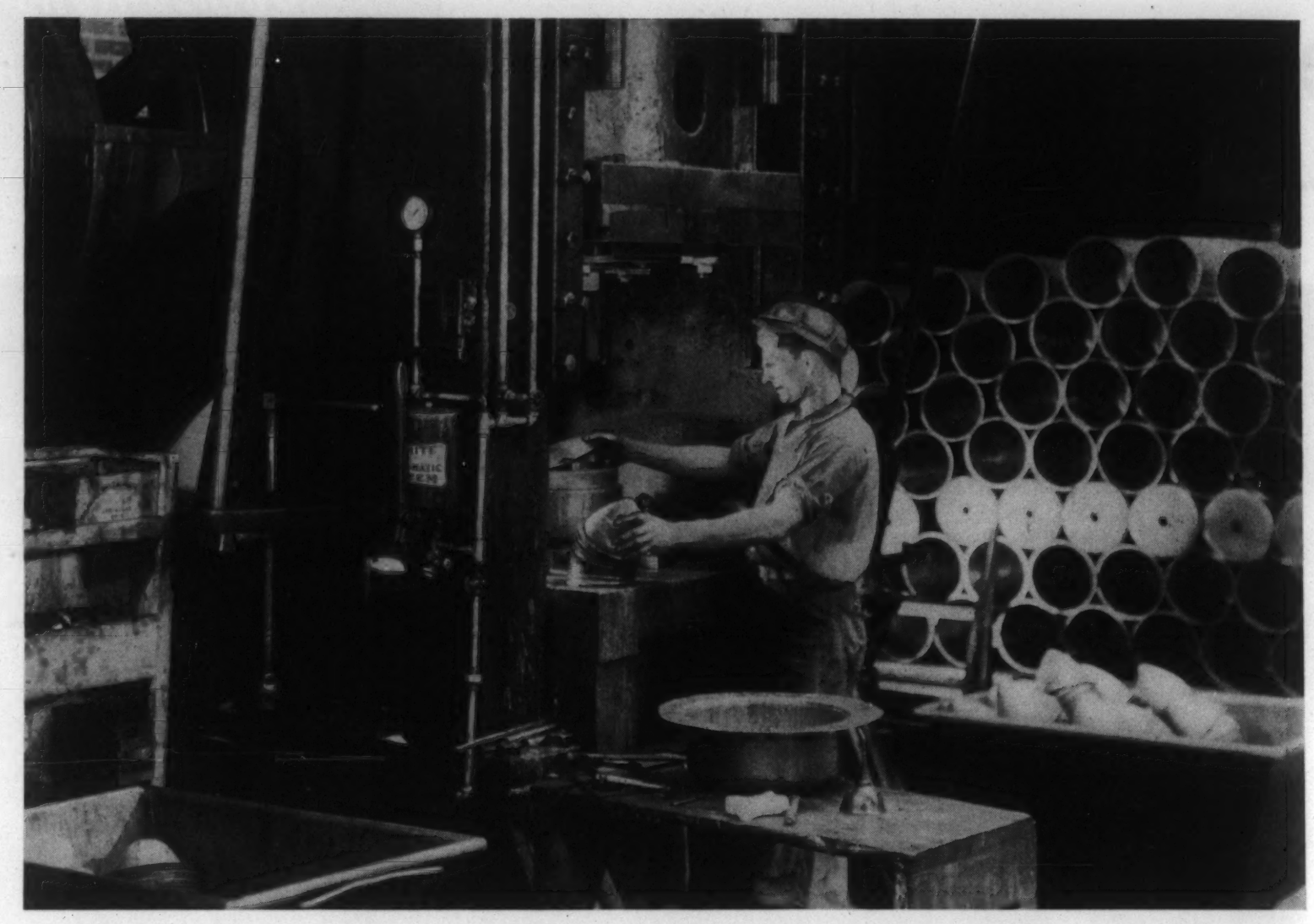
Scrap from stamping operations is usually less than that from castings or forgings with subsequent machining, and it is a scrap more easily handled and segregated than machine chips. Finish is better on the stampings than on unmachined castings or forgings. Pressed metal conversions aid in the manpower shortage also, for the presses require little skill in operation, and can easily be handled by women. In short, the same advantages which enabled pressed metal fabrication to cut costs in peacetime mass production have now been utilized in the ordnance program.

Conversion to stampings has been largely limited to small parts. It was just these small parts, however, needed in huge quantities, which had threatened to become a bottleneck in the entire production drive. The designers have shown amazing ingenuity in converting to presswork fabrication items laid out for

th Use of Stampings in Ordnance

Shatterproof oxygen cylinders for high-altitude flying are formed (half of the cylinder at one stroke) from disk blanks on this 750-ton toggle press, formerly used to stamp out beverage containers. (Courtesy: Office of Emergency Management; photo by Palmer)





This picture shows at a glance some of the various shapes — shells, cylinders, bowls, etc. — that can be fabricated on a high production scale by stamping and drawing. (Courtesy International Nickel Co., Inc.)

other processes. Frequently there has been a saving of metal by reducing the weight of the finished piece. At times a press assembly, or a staking operation, has joined several small stampings to duplicate a machined piece. Small gears for a timing mechanism are stamped out in one operation, freeing machinery for other uses while showing considerable saving in time and costs. In some conversions several stampings are joined by welds, usually spot welds, to make the finished item.

Irregular shapes which could be machined only with great difficulty can be produced in a single rapid operation on metal presses. Such pieces will frequently require several holes to be accurately located in relation to some part of the surface or to each other. Drilling such holes would require a jig, probably costing as much as the dies for press forming the piece, while in press fabrication it is often possible to stamp out and punch the work in the same operation.

Another source of pressed metal economy lies in substitution of plain steel or a similar "less-critical" metal for aluminum, stainless steel, brass, Monel metal, or other "more-critical" metal. Steel stampings have been made to replace aluminum die castings and to save not only the aluminum, but to be lighter in weight than the aluminum original.

Ordnance-Industry Collaboration

When the Army Ordnance Department decided to take advantage of these metal working facilities, a Suggestion and Conversion Section was formed to make possible the redesign of items for conversion from other fabrication methods. Established May 15, 1942, at the request of Maj. Gen. G. M. Barnes, chief of the technical division, it went to work at once. During the first month 50 ordnance components were studied and 17 were approved for conversion from forgings, cast iron, or bar stock to metal stampings. Marshall A. Blu was the Ordnance Department's technical consultant on stampings.

On July 1 of that year Brig. Gen. H. F. Safford, chief of the Production Service Branch of the Industrial Division, Ordnance Department, issued a general call for conversion of ordnance material to save man-hours, free machines for other work, and save material. A month later, recognizing that the skill to adapt items to press fabrication was largely in the plants of the fabricators themselves, the suggestion system for improving ordnance parts was established. Suggestions from industry are sent to that one of the 13 ordnance district offices located in that area. Conversion engineers are assigned to each office, and suggestions are screened and pro-

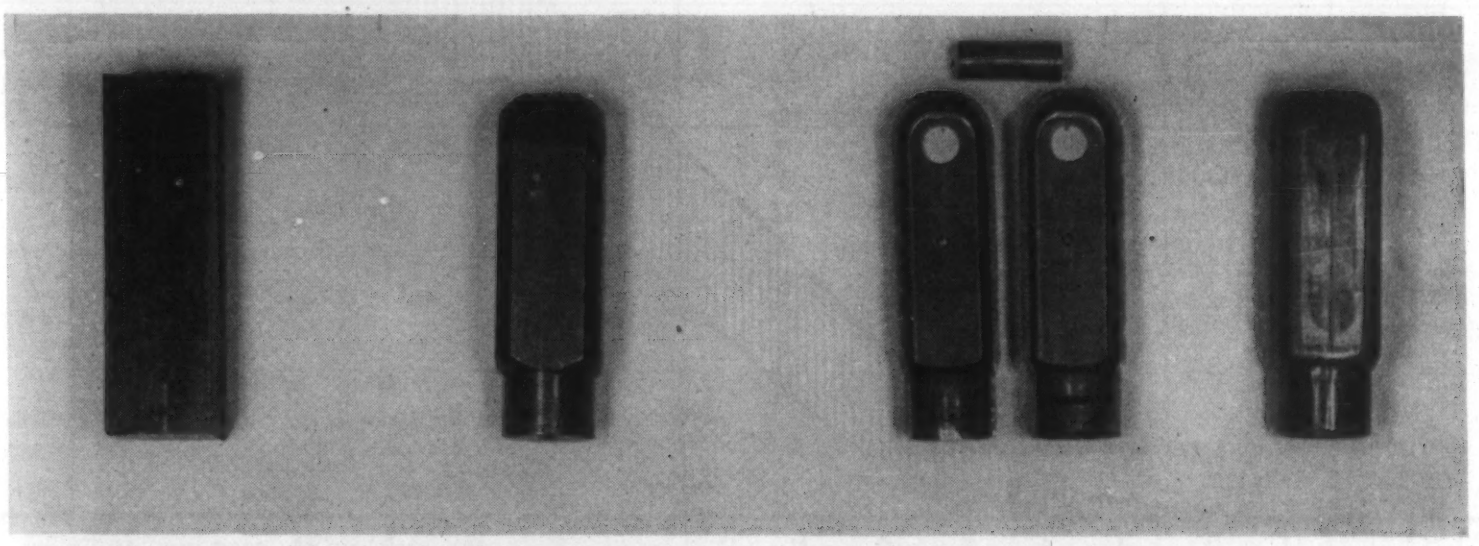
cessed in the district office before being sent to Washington. Those suggestions considered practical are sent to the ordnance engineer at the capital in charge of that component. To mid-year, 2,708 suggestions had been screened and processed, and 1,042 are now in production. Nearly 200 more suggestions were sent in during July.

This section of the Ordnance Procurement has grown so that it now requires the full time services of more than 200 engineers. Mr. Blu, the civilian consultant with the conversion group at its organization, resigned in July to return to private industry, and Maj. C. D. Alderman took his place.

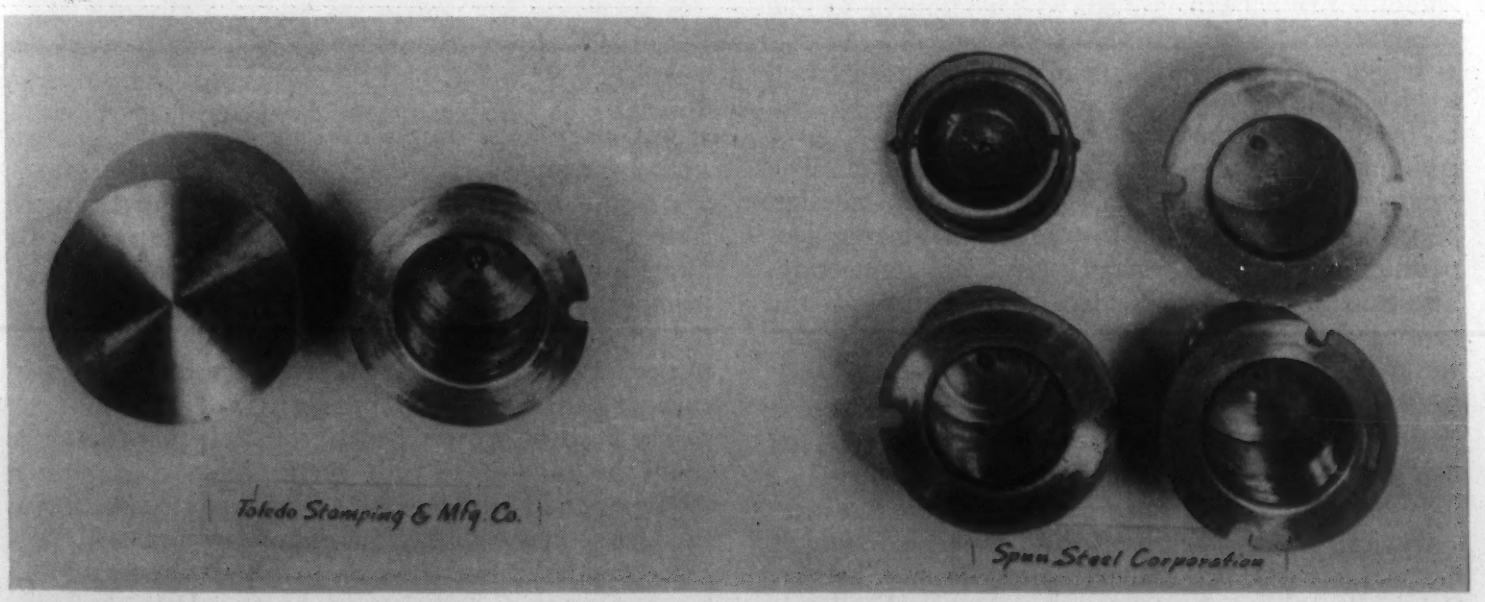
The results of the changes made thus far have been evaluated by the Army Ordnance Department on the basis of the 1943 ordnance procurement program. It is estimated that 64,000,000 lbs. of nickel, 17,500,000 lbs. of chromium, 5,200,000 lbs. of tin, and 4,300,000 lbs. of molybdenum will be released for the manufacture of other war material by substitution of low alloy or carbon steel for brass, stainless or other rich-alloy metals. Substitution of steel or other pressings for aluminum die castings or other forms will make available enough aluminum to build 25,500 fighter planes. Copper equivalent to 3,000,700,000 rounds of 0.50-caliber aircraft ammunition will be freed. Sufficient steel for the construction of 31,000 railroad oil tank cars is the estimated saving of that metal.

In addition to these savings of badly needed metal, "millions upon millions of man-hours" will be available for other work, and "countless numbers of critical machines" can be otherwise occupied.

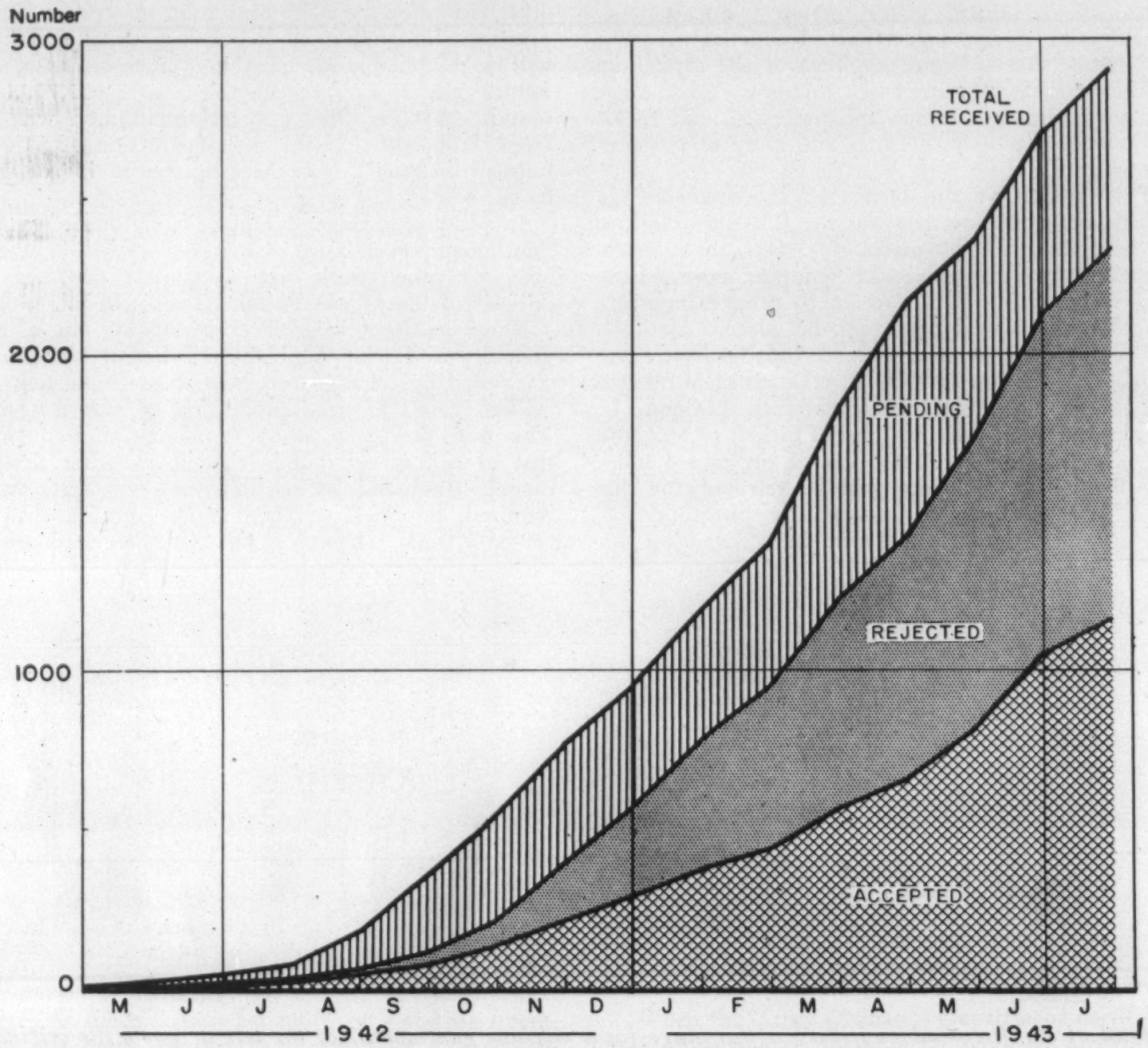
These results were achieved by solving one of the greatest production problems in history. The war compelled our changeover from mass production of civilian goods to mass production of war material. The transition was vastly more complicated than that of a few automobile models to other similar models—thousands of entirely new products were required, hundreds of them more complex than a car or a truck. There was not one integrated group



Typical of the "tremendous trifles" is this hinge for a machine gun mount. At the left is shown the original item, machined from 3.55 lbs. of bar stock, and requiring 12 min. time on lathes and milling machines. The stamped metal duplicate at the right weighs 1.7 lbs. The assembly is hydrogen brazed.



These booster cups for ammunition, formerly machined from 7.18 lbs. of bar stock, are now made as stampings weighing only 4 lbs. in a hydrogen brazed assembly, at a cost of 16 cents each.



Progress in Conversion of Ordnance Designs. Action Taken on Suggestions Received to Aug. 1, 1943

of factories, but thousands of scattered plants, large and small, all working with strange products. The emergency afforded no time for complete redesign by ordnance engineers. Instead the Ordnance Department set up its section for conversion engineering. The existing designs, intended for fabrication of the various components by forging or casting, were converted to forms suitable for rapid presswork fabrication largely by suggestions from the industry.

Some Typical Ordnance Redesigns

Typical of what has been done is the redesign of the earpiece for an artillery sound locator helmet. Originally this piece was a permanent mold aluminum alloy casting, weighing about 0.4 lb. and requiring 0.63 machine hours and 0.5 assembly hours. It was made to fit snugly over the ear of the listener. Four helmets, two for regular use and two as spares, are required with each locator. Projecting from the convex surface of the earpiece was an eccentrically located, integrally cast, machined and tapped tubular member to which the sound tube was attached. Near the edge of the casting 48 small holes were drilled to permit the sewing on of a sponge rubber, chamois-covered pad.

The head of a Brooklyn concern felt that this piece could be redesigned and made from a stamping. After a period of development the new earpiece was produced—a sheet steel stamping covered with low grade molded rubber pad, and with an attached tubular member made from steel tube on a lathe, but suitable for screw machine production. It is sturdy, light in weight, comfortable, and quite as effective as the

original model. The estimated savings for 28,000 earpieces are 12,000 lbs. of aluminum alloy, 12,000 machine hours and 13,000 assembly hours.

The trigger housing for the 0.30-cal. carbine, favorite with the Rangers, was made from a steel forging or casting weighing 1.3 lbs. It is now made as a steel stamping weighing 0.675 lbs. Costs were reduced from $6.00 to $2.00. Machine operations, formerly 36 in number, were reduced to 14, while machining time was lowered from 40 to 7.2 min. For every million carbines made, it is estimated enough steel will be saved to make 135,000 additional carbines.

The sight for the famed bazooka is an assembly of stampings. Instead of the estimated two months for developing the design in production, the work took 14 days. Two contractors were lined up by the Ordnance Department to make the sight, and each subcontracted a part of the work. The first found five small companies to make the dies and handle the stampings and assembly. Two of these had only eight employees, two others had 10, and one 50. One was a tool shop on a chicken farm. The second contractor sublet to three concerns, one with five employees.

Steel stampings have been combined to make a roller bearing retainer which requires no machining, weighs 40 to 55 per cent less than the conventional bronze part, and frees that alloy for other duty. The bearing pockets are rectangular stampings, as are the two side rings. After alignment the parts are spot welded for permanent assembly.

A company which formerly made mousetraps turned its attention to machine gun pintles. These pieces, as forgings, weighed 3 lbs. and cost $3.54. Redesigned as stampings, the weight was reduced to 2 lbs. and the cost to $1.50, saving 1 lb. of metal and $2.04 per part. The labor was also reduced by 50 per cent.

In the Aircraft Field

Of America's major industries, the one most expanded by the war is the aircraft industry. To obtain the required production of military aircraft, vast new plants have been built, new sources of supply of raw materials have been developed, and existing facilities of all kinds have been expanded out of recognition from the original. Programs of the Army Air Forces, Navy Bureau of Aeronautics and Aircraft Resources Control Office are consolidated in the Aircraft Production Board of the War Production Board. To conserve materials and facilities an operating committee on Aircraft Materials Conservation has been appointed, its duties including the recommending of changes in manufacturing processes where savings can be made.

This committee early recommended material substitutions where scarce materials could be conserved by this means. Late in July it announced that "greater emphasis" was required on "conservation through improved manufacturing processes." It pointed out that such conservation would not only save material, but labor also, while production delays and downgrading of quality could in many instances be avoided.

Savings on small parts can mount to huge sums in the large volume of units required. Savings on one order were estimated at $660,000 when an aircraft engine component formerly machined from stainless steel bar and tubing was converted to a sheet metal stamping. The saving of material was 80 per cent and the reduction in cost 45 per cent.

Substitution of a drawn carbon steel aircraft hardware item for one machined from stainless steel bar stock showed considerable savings of material. The former process required 285 lbs. of the critical alloy for production of 1000 units, while the necessary quantity of the carbon steel for the same number was only 62½ lbs. In addition, scrap production was lowered from 83.5 to 24.5 per cent.

An ordnance component was redesigned for conversion from castings to steel stampings, with estimated savings of more than $4,000,000. The unit was formerly machined from Monel and aluminum castings, while the conversion uses steel sheet and tubing. Savings of about 200,000 lbs. of copper, 500,000 lbs. of nickel, and a substantial amount of aluminum will result. The weight of the item has been reduced from 4.65 to 3.50 lbs., and the cost reduced 75 per cent.

The Future

While the conversion of war material fabrication to press methods is continuing, members of the industry have begun to think of the future also. They suggest that the same methods which made possible the low-cost mass production of so many peacetime items in the American market, and which have shown such wartime success, may be expected to fill needs in other industries in the post-war era. This position will be strengthened by the organization of the industry in the Pressed Metal Institute, with its opportunities for exchange of ideas, and by the collaboration and subcontracting which are a part of the making of war materials.

Engineers and designers have become increasingly aware of the economies possible by this rapid and accurate type of metal forming, and new metals, metal composites and alloys, developed by the war, will present new possibilities for the future in this field. Some of these, particularly an aluminum-steel composite, which had been used in the automobile field just prior to American entry into the conflict, have been developed for pressed metal plane parts, and the skill developed in their large-scale handling now will make their future use in more prosaic products easier.

Precision Castings f

Few industries were in as desperate a plight 18 months ago as the jewelry manufacturers. With their peacetime products indisputably classified as nonessential, raw materials except a few precious metals denied them by WPB order, and the trend of manpower away from industries like theirs beginning to develop, they formed themselves into groups determined to find means of contributing directly to the war production effort and thereby to become recognized as essential. Typical of the results obtained is this story of a New York pool of jewelry manufacturers who converted their facilities for making accurate rings and mountings to the production of precision castings for ordnance and aircraft. In pointing up their achievement, Mr. Wolf also presents a very interesting description of the so-called lost wax centrifugal casting process used and some of the engineering details of the ordnance application developed.—The Editors

by J. D. WOLF

Production Engineer, The Jewelry Crafts Assn., New York

RECENTLY AN ARSENAL was faced with a trying problem — that of quickly supplying several hundred small bronze precision parts to the French Army in Africa, urgently needed by their artillery units. This part had not been made here since 1921. When last manufactured, specifications called for machining from 2.5-in. bar stock. Operations involved turning, milling, profiling, reaming, drilling and tapping. Original tools and fixtures had long since been discarded and to design and execute new ones would entail a delay of many weeks. Furthermore, all machine tools in the arsenal shops were overloaded with other urgent jobs.

An alert Ordnance Officer recommended that precision casting might be employed as an alternative to machining. The process was investigated and, as a result, these parts were produced by the centrifugal lost wax process. These precision parts were cast so accurately that 95 per cent of the normal machining was eliminated, only a reaming operation being necessary. The entire job was completed in less time than would be normally required to design a new set of tools, jigs and fixtures.

The impetus of our wartime needs for more production, quicker and with less waste, gave this unique production medium an opportunity to prove itself. Prior to Pearl Harbor, little attention was evidenced toward centrifugal casting of small parts, except within the jewelry industry, where it has been widely used for a decade for the manufacture of rings and mountings on a mass production basis. It remained for William B. Ogush, president of the Jewelry Crafts Association in New York, to demonstrate that centrifugal castings could be employed as a means of small parts production with a resultant savings of tons of raw materials and thousands of man-hours in production time.

With the event of our entry into the war, Mr. Ogush was determined to throw the weight of his industry to the balance of war production. Through his efforts, metallurgical engineers were consulted and immediate experiments were made in brass, stainless steel and heat treatable bronzes. It was found that excellent specifications could be maintained, even in the smaller jewelry plants, and that cams, gears and other small intricate parts could be cast accurately to within a few thousandths of an inch.

The War Production Board and the Smaller War Plants Corp., interested because of the potential savings in critical metals made possible by precision casting, assigned their engineers to find applications whereby this method could serve as an alternative to machining. Their assistance enabled jewelry plants that formerly were casting rings and mountings to execute commitments for sorely needed precision parts in less time than that estimated for the more critical metal forms, such as bar stock and forgings, to be delivered from the mills.

Production Advantages

Several immediate advantages are evident to the production executive for employing a wider use of centrifugal casting as a method for the manufacture of small precision parts. At this moment, probably most important is that ingots or scrap metal can be used as raw material, thus reducing the hazard of delayed deliveries of pre-processed metals which are essential for conventional machining methods. Furthermore, numerical quantities of finished parts can be multiplied, compared to that of machining from any given weight of raw metal, since precision casting leaves no metal scrap. The cost of alloys in ingot form, or of scrap that may be alloyed within the production plant, is only a fraction of that of bar stock, forgings or rolled flat stock necessary to start machining operations.

Equally evident is the saving in tooling costs as compared with the time and expense of jig and fixture preparations essential for intricate machining procedure. Tooling for casting production merely involves the preparation of accurate molds, which for small parts rarely requires more than 40 hrs. of toolmaking.

A study of the comparison chart of the three typical precision parts illustrated will help to indicate the possible saving in tooling, raw material and production costs that may be effected where precision castings can substitute for conventional machining. This table or chart might serve as a rough yardstick in estimating potential savings for similar parts.

WARTIME ENGINEERING ACHIEVEMENTS

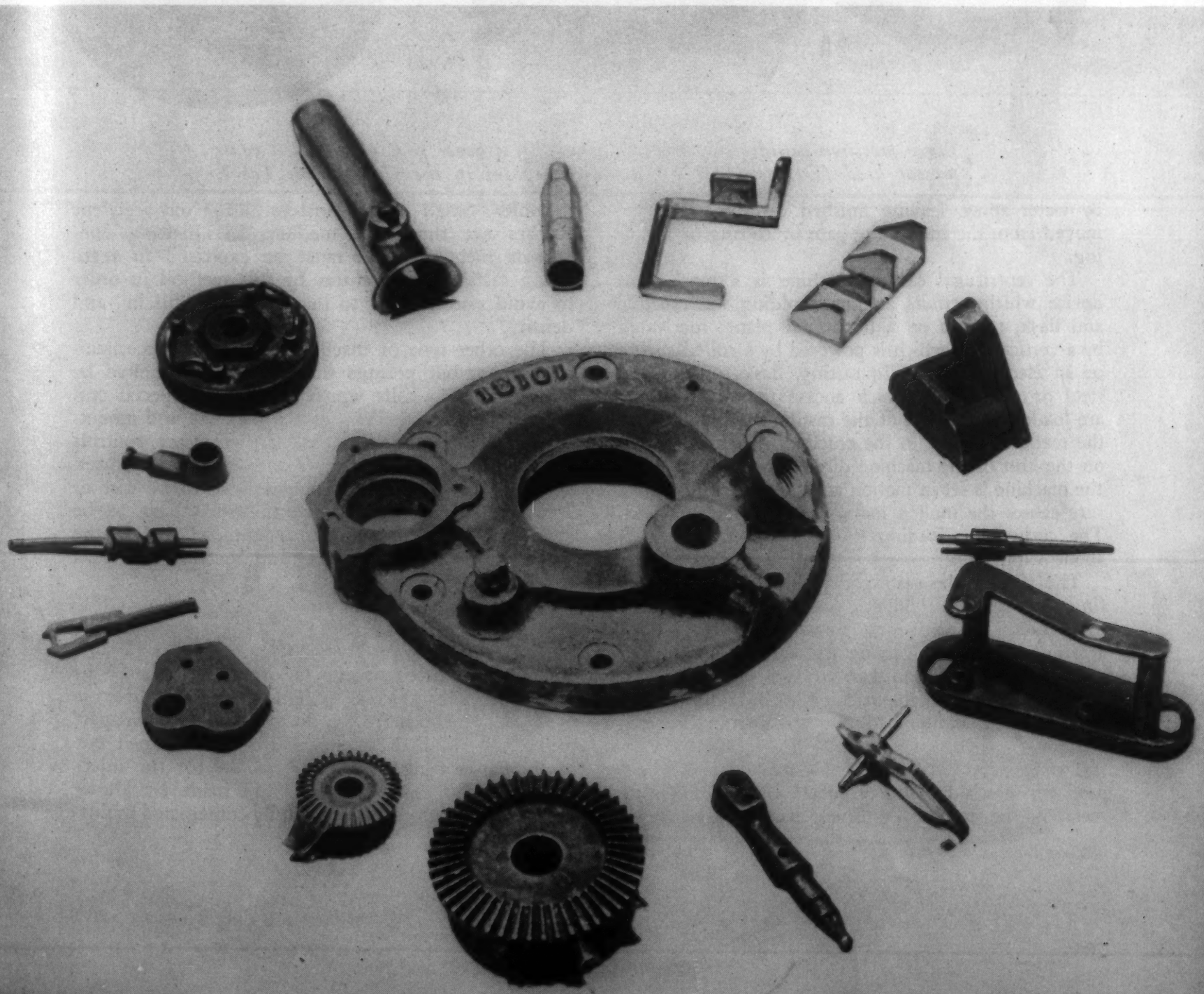
ngs for Ordnance and Aircraft

In instances where precision casting can substitute for a long series of successive machining operations on a given part, losses due to rejections can be greatly reduced, because a rejected cast part only involves the loss of a single operation. Since the weight of raw metals for casting is much less than quantities required for machining, both handling and traffic costs are automatically lowered. Losses due to warpage in heat treatment are largely eliminated in centrifugal castings since there is no occasion for the development of machining or forging stresses. Porosity in a centrifugally cast part can usually be observed from an external view; losses from this source can therefore be subject to better control than where sand or die castings are used.

Process Described

The mechanical phases of centrifugal casting operations are relatively simple. Progressive steps consist of first making wax models of the part to be produced, imbedding these models in moistened plaster, dehydrating this plaster, then melting out the wax in a furnace, thus leaving cavities in the hardened plaster. This plaster (called an investment) containing the cavities, is then mounted on the arm of a centrifugal casting machine and molten metal is injected by centrifugal force into the cavities by means of a gate in the plaster mold. The mold, now impregnated with metal, is removed from the machine and cooled, the plaster is then dissolved

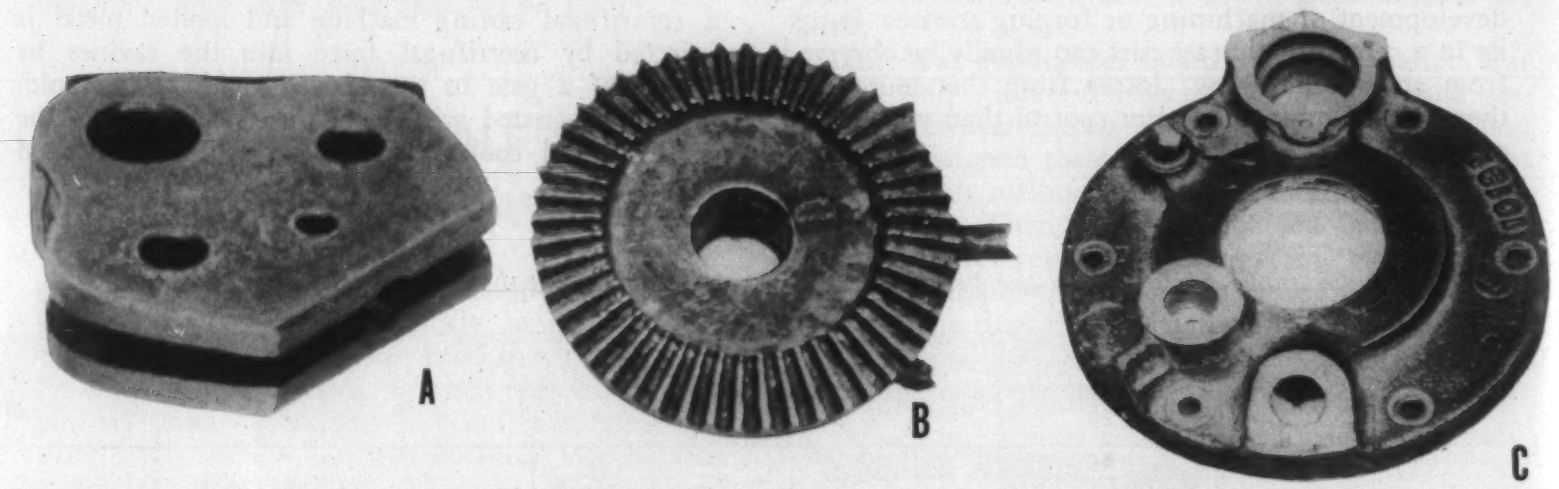
Various small parts cast by the precision process. (All photographs taken by Walter S. Moch.)



Comparison Table of Costs and Time

	Casting "A," Connector Arm*		Casting "B," Bevel Gear*		Casting "C," Compressor Head*	
Size	1" x 7/8" x 1/4"		Dia. 1½"		Dia. 3½"	
Material	Brass scrap	Flat stock	Tobin bronze ingots	Bar stock	Al. Ing. (108)	Sand cast (108)
Quantity	1,000		4,000		250	
	Prec. Cast	*Machined*	*Prec. Cast*	*Machined*	*Prec. Cast*	*Machined*
Man-Hours, tooling, total	20	125	30	80	40	250
Man-Hours, production per unit	5 mins.	8 mins.	6 mins.	8 mins.	30 mins.	120 mins.
Scrap, per cent	2	40	2	60	3	55
Rejections, per cent	3	6	3	5	4*	25**
Waiting Time Raw Material Delivery	5 days	60 days	3 days	21 days	7 days	30 days

* These refer to one of the illustrations.
** Subject to 100 per cent inspection for porosity.



Three precision castings, a connector arm (A), a bevel gear (B), and a compressor head (C), used for comparison purposes in the Comparison Table.

by water spray, leaving finished castings to be removed from the connecting gate by cutting or grinding.

The centrifugal casting machine is a mechanical device which permits an arm, holding the crucible and flask, to spin on a horizontal plane, motivated by a vertical axis which is powered by a coiled spring or an electric motor. In casting, flasks of stainless steel or aluminum (which encase the investment), are loaded on the arm of the casting machine. When the metal is melted in the crucible, which is located on the arm of the machine directly behind the flask, the machine is set in motion and the centrifugal pressure causes the molten metal to flow into the flask. The cycle from loading to removing the flasks is about 3 min.

The size of the casting machine selected is contingent upon the weight, size and contour of the units to be cast. The size most frequently employed has a radius in the arm varying from 12 to 18 in. In straight line production, two workers tend each machine, one to operate the machine itself, and the other to load, melt and unload the flasks from the machine.

Two general types of centrifugal machines are used for precision parts production. One permits metal to be melted by direct flame in an open crucible. Small gas furnaces and oxy-acetylene torches are the usual medium for melting nonferrous metals. Skill must be exercised in regulating casting temperatures by this method in order to avoid porosity and to insure proper "fill in" and density.

The other type of machine is of similar mechanical design, but permits the metal to be melted by electric heating coils which surround a special crucible attached to the arm of the machine and mounted directly behind the flask. Pyrometer controls are used to insure casting at controlled temperatures. When large quantities of metal have to be cast or when strict metallurgical specifications have to be maintained, electric induction furnaces provide the best medium for both speed and metallurgical control.

Wax Models Used

Precision force casting is often referred to as "the lost wax process." This is because wax is used as a medium to produce models of the part to be cast, and these waxes are later burned out of the investment to prepare cavities for the injection of metal. Wax models are made by allowing melted wax to cool in specially constructed molds.

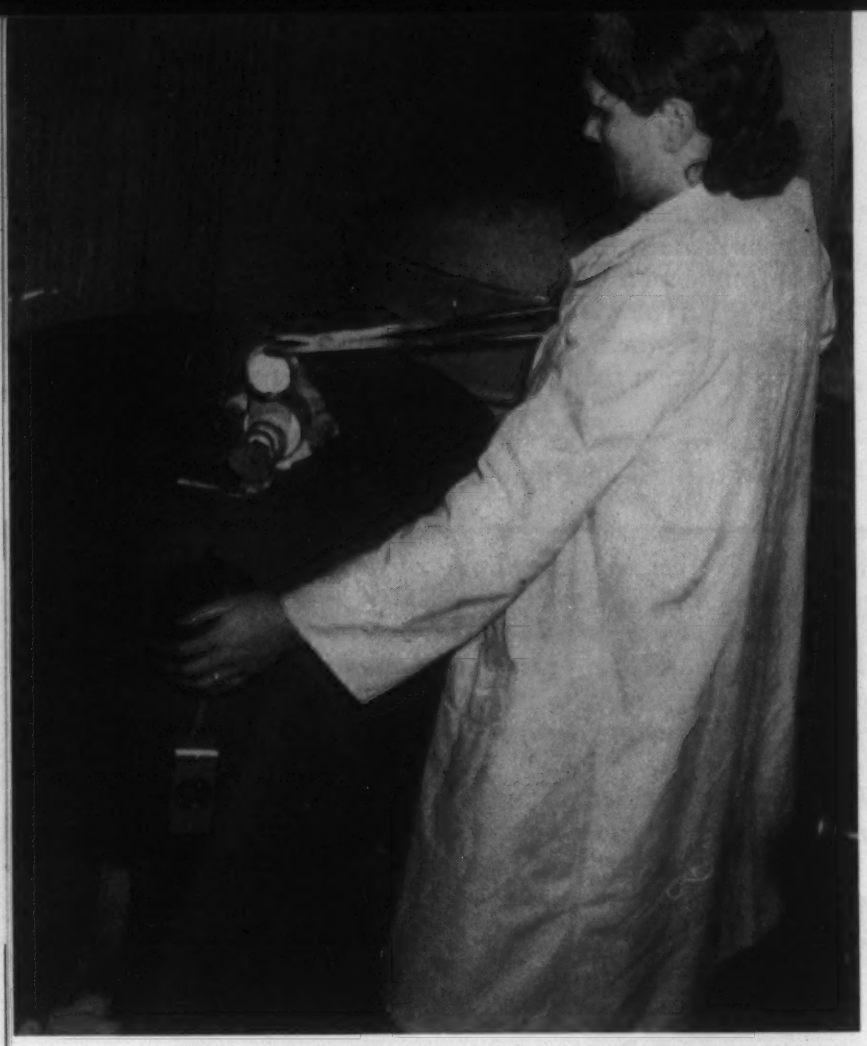
When the wax has cooled the mold is split and the wax reproduction carefully removed.

Wax molds are made in three types: Solid steel, low fusing metal, or vulcanized rubber. Great care must be taken in the designing and preparation of the molds to allow for shrinkage, and to avoid split lines. The choice of wax composition, from beeswax to synthetic formulas, is dependent upon the size, contour and handling qualities desired.

In recent months, important experimental progress has been made with plastics as a substitute for waxes in the production of casting models. The indicated advantage in plastic models is that they are much stronger and when produced on a mass production basis in injection molding machines, the cost is much lower.

Waxes are produced in the jewelry industry on small centrifugal machines which are very compar-

Pressure Gage and its Parts: The pinion gear at left is cast in 2. per cent beryllium-copper. Parts cast in this alloy are characteristically smooth and fine grained. The material machines readily and may be precipitation hardened to tensile strengths exceeding 110,000 lbs. per sq. in. This part was formerly made from a brass stamping that was drilled and tapped and the teeth of the gear were milled. The pinion was produced on a Swiss automatic and pressed through the center hole. The frame at center wa cast in one piece in brass. It formerly was made by assembling two stamped flats with two hollow turnings; the bushings were press fitted into the bottom flat before assembly. The pinion gear at right is cast in phosphor bronze, replacing production by machining teeth by index milling on screw machine blank. The parts are shown below as assembled in the completed product.*



A worker pouring molten alloy into crucible of the centrifugal casting machine.

able to the metal casting machines, but lighter and smaller. In instances where metal molds are used or when the design of the unit requires a high cubic content of wax, specially designed pressure devices are employed to inject wax into the molds. Some of these machines act on hydraulic principles, while others rely on air pressure to force wax into the mold. It is desirable to use pyrometers and pressure gages in conjunction with the pressure devices in order to insure against wax shrinkage.

Current Applications

Theoretically, almost every type of contour found in machined parts can be duplicated by precision casting. Tapped and threaded areas, gear teeth, undercuts of all descriptions, tapers, fillets and chamfers, square, round or elongated holes, or any combination of these can be cast in one unit. However, centrifugal castings cannot compete on a cost basis with stampings or automatic screw machine products. Some of the newer, stronger non-ferrous alloys, including beryllium-copper and manganese bronzes, lend themselves to this process very well, as do all the conventional sand casting and die casting metals.

In order that the scope of possibilities might be better realized, the following items now being produced by centrifugal casting as a substitute for machining are briefly described, as an illustration for comparable uses:

Instrument Parts: Bronze and beryllium bearing mounts, sector and pinion gears, pressure and suction gage parts, instrument frames, diaphragm holders, cams and pinions.

Surgical: Stainless steel instrument handles, retractors, instrument parts in stainless steel and beryllium alloys.

Aircraft: Toggles and supports, small gussets, precision parts for oxygen equipment controls, starter parts in silver and aluminum alloys, stainless steel exhaust fittings, and turbine blades.

Ordnance: Bronze and stainless steel triggers, nonferrous precision parts, sighting and telescopic small parts. Currently, experimental gun parts are being made in high carbon and alloy steels.

Facilities Available

The prime contractor or procurement officer, who is interested to obtain immediate and economical small parts production, will find adequate facilities existent and available within the jewelry industry, in plants approved for war work by the official agencies. Those having production difficulties, mechanical or metallurgical, might well find a satisfactory solution by the adoption of this method. It is estimated that current production facilities within the jewelry industry alone, are adequate for the production of 100,000 small parts weekly on a subcontracting basis.

From an engineering viewpoint, it is desirable to view the prospective production process when original designs and specifications are being developed. Faster production rates can be obtained and better metallurgical properties can be developed in precision castings, when engineers carefully consider the limitations and advantages of centrifugal casting methods, before approving production specifications and drawings. Impressive economies to the prime contractor can be effected when overall engineering liaison is encouraged between his designing staff and the prospective producer of castings. Production "bugs" can be often avoided when it is possible to design the piece to fit the process.

The Outlook

If this method gains popularity as a production process, wider applications, bringing new production experience, will result in improved technique as a natural sequence. If general technical improvements in the process can continue at the current rate, it is logical to anticipate that precision casting will be employed to a greater extent in post war manufacturing.

Production men with an eye to the future afe studying this process now for its possibilities in the mass production of small parts for the automobile accessory industry, outboard motor, refrigerator, and allied fields.

The small parts user who fails to study the possibilities of this process might find that he has been left behind as the result of his competitors' foresight. While most centrifugal casting within the jewelry industry is now confined to non-ferrous metals and stainless steel, it is hoped that new ferrous alloys, adaptable to this casting procedure, will soon be developed.

WARTIME ENGINEERING ACHIEVEMENTS

The Pressure Quench for Armor Plate

A major problem in heat treating armor plate is the distortion of the plate. Overall flatness specifications are such that armor plate which has been quenched by ordinary tank or spray methods must be mechanically straightened afterwards. In many armor-treating shops that portion of the total time, labor and expense consumed by straightening alone is the largest single item on the work or cost sheet. Therefore one of the outstanding achievements of recent months has been the development and use of a new pressure quench that automatically keeps the plate straight during the quenching process and obviates a large part of the separate straightening operations. The engineering features of this pressure quench and the operating experience with it of two large manufacturers of light armor plate are described in this article. —*The Editors*

by FRED P. PETERS

DURING THE PAST YEAR several changes in our military situation or strategy have resulted in revisions of manufacturing programs all along the production front. One of the most widely felt has been the recent shift in emphasis from tanks as a weapon to mobile armored artillery. This development has focussed attention on the production of relatively light-gage rolled homogeneous armor plate and therefore on the engineering problems associated with its manufacture.

Foremost among these problems has been the production of dead-flat heat treated plate without a prohibitive expenditure of time and money for straightening distorted plate. Light armor plate is notoriously subject to severe distortion when water-quenched from the hardening temperature into an ordinary tank without auxiliary clamping devices to hold it straight. Many shops are actually hardening plate in this way and then employing considerably more manpower and time in straightening the plate in presses or roller-levelers than was required for the hardening operation itself.

Those shops who sought improvement have usually first gone from their ordinary practice of pulling the heated plate out of a batch-type hardening furnace and dunking it in still tanks to the use of a press-type clamp affixed to the plate before it is quenched, together with circulation of the quench water in the tank. Although this introduces its own mechanical problems, it is a considerable improvement over "unconfined" quenching. The next evolutionary step is usually the installation of a "spray-quench" system, whereby the plate is passed or pulled out of a continuous or batch furnace through an open water-spray that impinges uniformly on all areas of the plate. Spray-quenched plate requires much less straightening than plate jig-quenched in a tank, but it goes far short of eliminating the straightening problem.

A real achievement in this direction, however, is an automatic "pressure quench" machine manufactured by The Drever Co., Philadelphia, and now in use by some dozen plants in this country and Canada. This pressure quench is used in conjunction with a continuous roller hearth furnace and consists essentially of an ingenious but simple arrangement for pressing the plate uniformly on both faces and simultaneously spraying both faces with water *from the pressing unit* as the plate emerges from the furnace. The pressure quench has been applied chiefly to hardening furnaces, but there are some advantages to its use in addition at the exit end of tempering furnaces, and a few installations of this type exist.

The Drever pressure quench has been so successful in eliminating virtually all distortion during the heat treating of armor plate and in producing plate of strikingly uniform hardness that a detailed description of its construction and operation and a report of some users' experience with it are warranted, if only for the purpose of speeding armor plate production in general through a wider adoption of this method of quenching.

Construction and Operation

The basic principle of the pressure quench is shown schematically in Fig. 2. It consists primarily of a rugged structural steel framework with a *stationary* upper press platen (A) and a *movable* lower platen (B). As the armor plate C emerges from the continuous hardening furnace it passes onto the separately driven conveyor rollers D and these are

stopped at the moment the plate is entirely on them and located between the platens. This is the "ready-for-quenching" position in the illustration. The lower platen then rises to the "quenching" position shown, lifting the plate off the rollers and holding it under controlled pressure against the upper platen. When in this position the quench water is then sprayed out of the platens onto both surfaces of the plate. When quenching is completed the lower platen is lowered, the plate is deposited once more on the roller conveyor, which then carries the plate into the tempering furnace.

Details of the construction of the pressure quench may be seen in Fig. 3. The upper platen is equipped with a series of hollow water boxes with projecting lugs, pointing down (these are shown very clearly in Fig. 4). The lower platen is mounted on a structural framework or elevator platform that is movable vertically, and is provided with a series of water boxes with lugs projecting upward to meet the lugs of the upper platen. When in the quenching position, the armor plate is held between the projecting lugs of the two platens.

The roller table that carries the plate from the furnace into the quenching position, and which remains stationary while the platens move and quenching proceeds, is power-driven separately from the roller-hearth in the furnace. The water boxes of the lower platen are spaced between the rollers so that when the elevator rises the lugs pass between the stationary rollers and lift the plate off them.

The press is operated by a self-contained motor-operated oil-hydraulic system capable of exerting a total pressure of 18 to 40 tons, depending on the installation. Water is supplied through a multitude of orifices drilled into the water-boxes—at the rate of 2,000 gals. per min.

The conveyor usually has rolls on 9 inch centers,

Fig. 1. Nemesis of the enemy's tanks, the Army's speedy, maneuverable and hard-hitting M-10 "tank destroyer" shown here is typical of the brand new fighting weapons designed for changed strategical needs. For its sloped hull and turret an increased proportion of light, homogeneous hardened armor plate is required. (Courtesy: Fisher Body Div., General Motors Corp.)

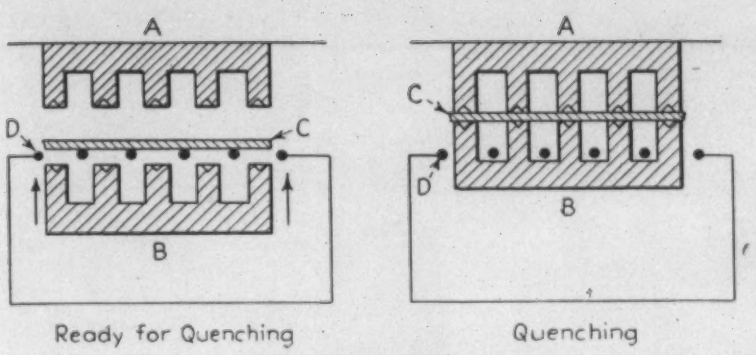


Fig. 2. A schematic representation of the operation of the Drever pressure quench. "A" is the stationary upper platen; "B" is the lower platen, which moves upward when the plate "C" on the rollers "D" reaches the ready-for-quenching position.

with self-aligning anti-friction bearings. The water-spray is operated through an air-pressure diaphragm, the flow of air to which is controlled by two 3-way solenoid valves actuated by a push button on the control pulpit. One such control pulpit from which adjustments can also be made in furnace temperatures and speed of roller hearth or table, is shown in Fig. 5.

At Standard Steel Spring Co.

The pressure quench installation, the heat treating practice and other aspects of armor plate manufacturing at Standard Steel Spring Company's plant No. 1 at Coraopolis, Pa., are of considerable interest.

This plant has a number of heat treating furnaces, including one complete continuous furnace line for hardening, tempering and hardness-testing armor plate comprising a continuous roller hearth hardening furnace, another pressure quench—all made by The Drever Co.—and a grinding machine and Brinell tester at the end. The armor plate sizes normally processed are 45½ to 68 in. width, ⅛ to 2 in. thickness, and up to 212 in. length.

The amount of production of the furnace line is of course dependent on the sizes of plate being processed. Thick plate or plate of an optimum width with relation to the furnace width will give higher hourly tonnage than lighter plate or plate that fails to occupy the full width of the furnace. The average production of the line in question is about 2½ tons per hr.

The hardening furnace is 60 ft. long with a hearth width of 6 ft. It is a 6-zone gas-fired unit capable of producing a maximum temperature of 1650 deg. F. The last 3 zones are the "soaking" zones, and are kept at the hardening temperature (this is considerably below the maximum for which the furnace was designed), the 3d zone is 60 deg. F. below the hardening temperature, the 2d zone 250 deg. F. below and the entering zone 400 deg. F. below the hardening temperature. Temperature control is effected through Leeds & Northrup Micromax controllers for all zones and an indicator-recorder for one hardening zone.

The pressure quench for hardening is 18 ft. long (exclusive of run out tables). Cast iron platens are used and the quench water comes from the company's own wells at a constant temperature of 57 deg. F. The spray holes are 9/64 in. diameter and the water pressure is 45 lbs. with the valve open. An air line is installed at the exit end of the quench to blow water and loose scale off the plate as it emerges (Heavy-gage stock, however, is burner-dried before tempering).

The tempering furnace can provide a maximum temperature of 1250 deg. F. (again, much higher than actually used). It is a convected-air type unit equipped with Wheelco Flame-o-trols for safety and to prolong the life of the air ducts.

A second pressure quench unit follows the tempering furnace. This is similar to that used for hardening, except that less time and water are required for quenching (the pressure quench after tempering consumes 800 gals. of water per min. when in use).

The Operations Involved

A typical job at this plant is the hardening of 9/32 in. plate, 45 or 50 in. wide. The hot-rolled plate is

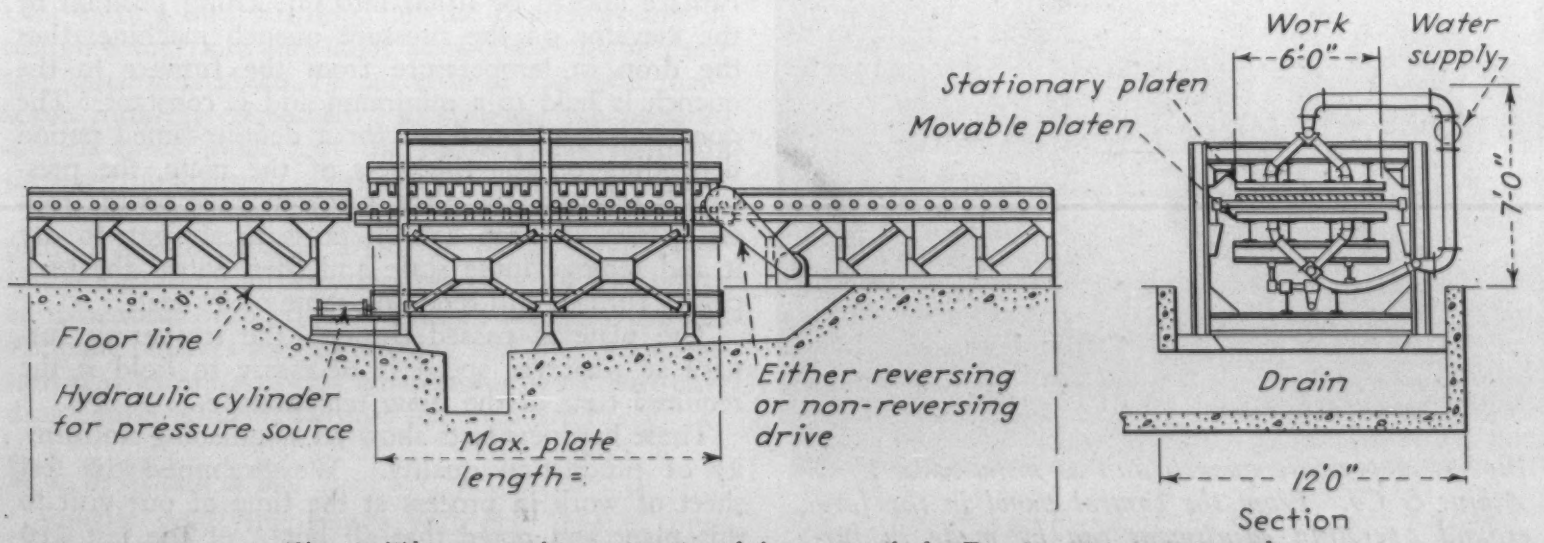


Fig. 3. The general constructional features of the Drever pressure quench.

Fig. 4. The pressure quench as it appears in an idle moment, with the stationary upper platen, its spray-water supply cables, and the conveyor rollers clearly visible.

tested *before delivery* from the mill (before rolling, in fact) by having sample plates from this heat rolled and sent to Standard, where they are heat treated and tested for physical properties. These heat-treated samples are finally tested ballistically at a proving ground before the lot is accepted for delivery.

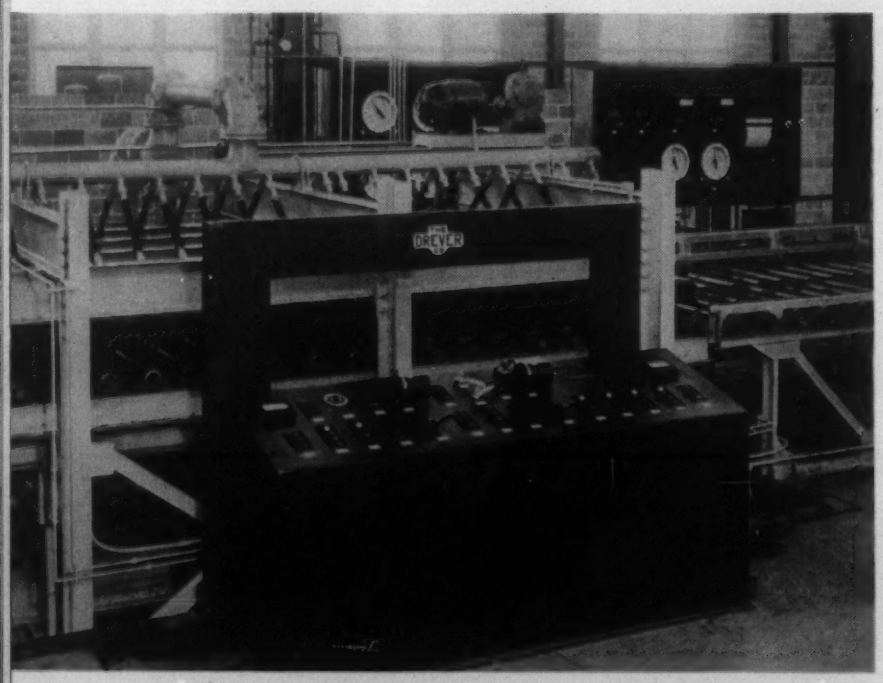


Fig. 5. A pressure quench unit as installed at E. C. Atkins & Co. From the control panel in the foreground operating adjustment can be made in furnace temperatures, roller hearth or table speed, etc.

The temperatures and time used in the heat treating of the production plates are determined by the heat treating necessary for ballistic approval of the heat. The hardening and draw temperatures and time will- vary with the analysis of the steel and gage and the specifications under which the plate is being processed.

The plates to be heat treated are loaded on to the rolls of the charging table. The speed of these rolls is so regulated that the plate is passed into the 6-zone hardening furnace and held at the hardening temperature for the required time. When the plate reaches the discharge end of the hot zone it is passed by fast rolls (operator controlled) to the quench.

It requires 2 sec. for the plate to go from the furnace and to be lifted into quenching position by the elevator on the pressure quench machine; thus the drop in temperature from the furnace to the quench is held to a minimum and is constant. The quench water then flows for a definite-timed period depending on the thickness of the plate, the pressure is released, the plate is re-deposited on the rollers, passes through a high pressure air gap to dry it and remove loose scale and then enters the tempering furnace still retaining some of its heat.

The plate is passed through the tempering furnace at whatever speed is necessary to hold it the required time at the draw temperature.

These hardness tests show an astonishing uniformity of production quality. We examined the test sheet of work in process at the time of our visit to this plant and noted that all but 3 of the last 210 tests on the sheet gave exactly the same hardness

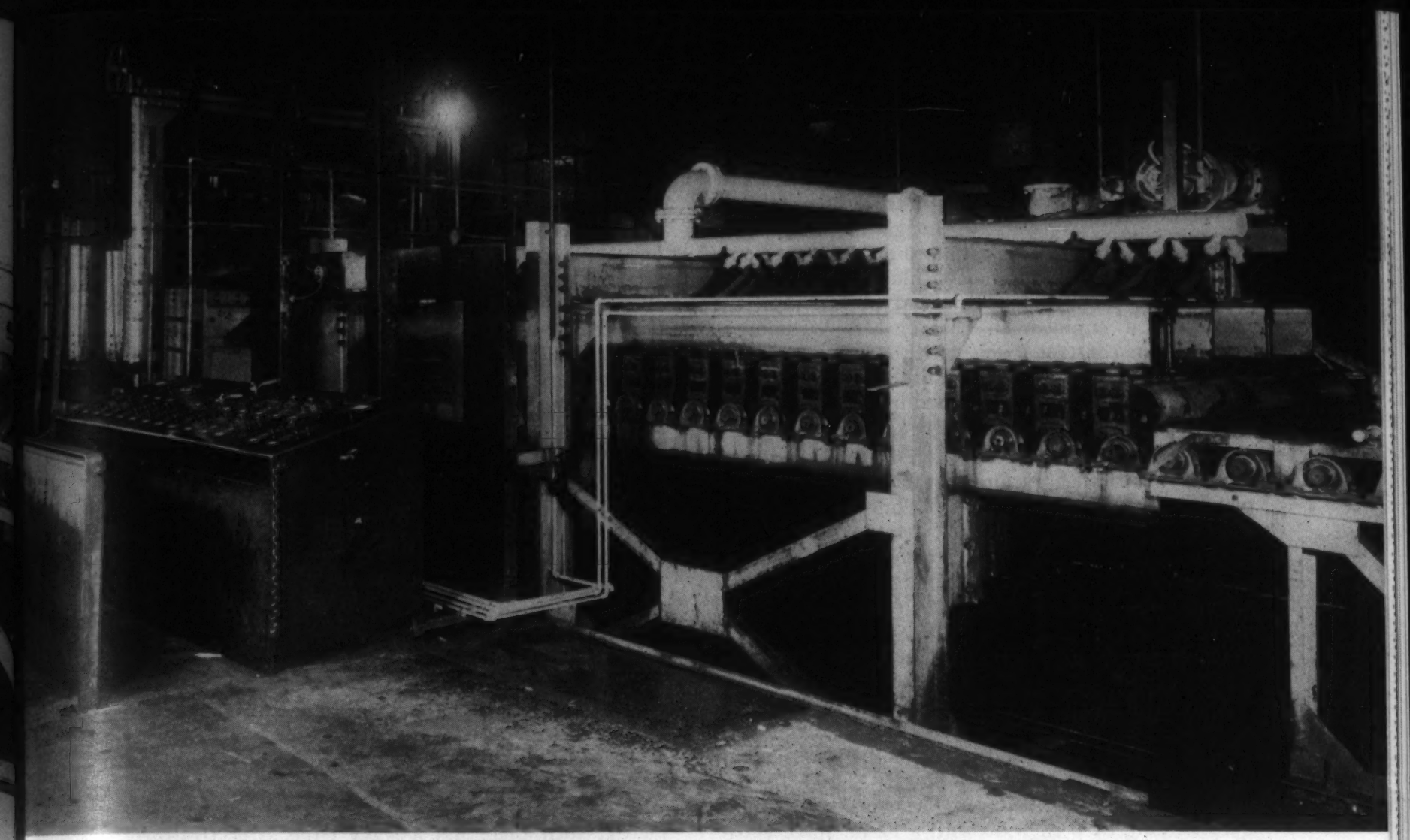


Fig. 6. Standard Steel Spring Co.'s pressure quench machine in the quenching position, with the lower platen pushing up against the upper.

reading, and those three were well within the specification limits. In addition Ordnance Dept. inspectors make random samplings of production for ballistic testing, and rejections are very very rare.

This company's unit has been in operation since April 1943. They are fully convinced after trying all the quenching methods in use that the use of a pressure quench of the type described is "the only way" to harden armor plate with the minimum amount of distortion. In conjunction with continuous furnaces the pressure quench provides them with the fastest possible production of virtually 100 per cent uniform plate and without subsequent headaches. *All* the rough straightening formerly necessary on plate lighter than about ½ in. is eliminated. Some finish straightening is usually necessary after cutting and burning, but the overall saving in straightening time and labor attributable to the pressure quench is about 75 per cent of the total man-hours formerly consumed. In addition the pressure quench saves about half the furnace-work normally involved on plate of these sizes.

It is of interest to note in passing that this company is hot forming a large part of its armor plate, as the unfolding military strategy calls for tanks with an increasing proportion of formed components. The company believes the engineering and production lessons it is learning in this hot-forming work will have direct application in its post-war manufacturing.

At E. C. Atkins & Co.

Equally gratifying results with this type of pressure quench are being obtained at the Fall Creek Ordnance Plant of E. C. Atkins & Co., Indianapolis, under the supervision of Mr. Frank R. Weaver, managing director. This plant has 2 Drever furnace lines equipped with the pressure quench in use. Atkins is believed to be the first to have made homogeneous hardened armor plate for Specification AXS 711 in hardnesses greater than 360 Brinell.

The saw industry (Atkins' nominal peacetime business) was using its own type of pressure quench years ago—a device combining a clamping jig and a

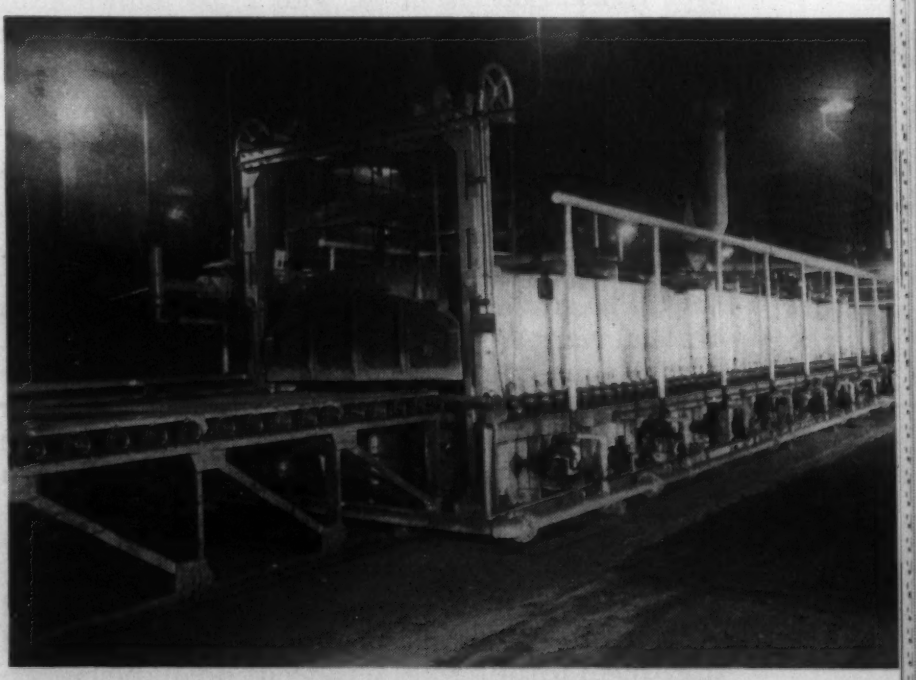


Fig. 7. The charging end of the roller hearth hardening furnace at Standard Steel Spring Co.

tank quench—so that this company was nicely predisposed toward the automatic pressure quench when it first became available. Although the Fall Creek Ordnance Plant (a new wartime shop) has used only the pressure quench for quenching since it began armor plate production at the end of last year, the metallurgical engineer in charge, Mr. William L. Appel, is in constant touch with the company's subcontractors in this program and hence is fully acquainted with the results obtained by other quenching methods as well.

Atkins armor plate production is mostly in sizes under ½ in., with facilities available for handling plate up to 6 ft. wide and 14 ft. long. Some of the plate is fabricated before heat treatment and some after. The tonnage processed in the pressure quench equipment *averages* 1½ tons of light plate per hour per line; the production of the heavier sizes often considerably exceeds this figure.

The lines are almost identical in their equipment and are also similar in most respects to the equipment at Standard Steel Spring Co. The hardening furnaces are gas-fired continuous roller hearth furnaces capable of operating at temperatures up to 1650 deg. F. and of handling 50-70,000 lbs. of armor plate per 24-hr. day. The working chamber is 40 ft. long by 6 ft. wide with a 12-in. space above the rollers.

Each hardening furnace has 4 zones. All are set for the same temperature, but the first two are pulled down by the cold plate being constantly charged; the last two zones are always at the hardening temperature. The zone temperatures are controlled by 4 Brown controllers with an additional multiple-recorder in regular use. The furnace lining is insulating refractory (2500 deg. F. grade) backed up by 2 in. of block insulation.

Four motor operated American Temperature Controls Co. valves regulate the air and gas supply to the furnace. Combustion is performed in 13 return-type combustion chambers, with a gas burner firing into one end of each chamber. The hot gases are passed through the furnace. The combustion chambers are faced with silicon carbide rectangular tile cemented to support-walls of high-alumina brick.

The pressure quench in each line is separated from the hardening furnace by 5 ft. 3 in. of roller table. The quenching machine has a quench area of 14 ft. 3 in. long and 6 ft. wide and operates in every respect like that at Standard Steel Spring Co. The time of quench is varied with the size of the work. The pressure on the plate is held constant at a figure between 50 and 75 lbs. per sq. in. with the water pressure varied for each set-up. A 15-ft. discharge roller table carries the plate from the pressure quench into the tempering furnace.

The latter is a 2-zone furnace whose working dimensions are 40 ft. long and 6 ft. wide. It can deliver temperatures from 300 to 1200 deg. F. and is heated by 2 recirculating type air heaters mounted atop the furnace, with separately fired combustion chambers. Each heater has a heat-resistant alloy fan capable of moving 7900 cu. ft. of air per min. at a maximum temperature of 1250 deg. F.

Draw temperature control is effected through potentiometer controllers (an indicating-controller in one zone and a recording-controller in the other), each of which actuates an automatic control valve mechanism of the 3-position type for regulating air-flow to the burners in the combustion chambers.

A pressure quench unit identical in design to the one between the hardening and tempering furnaces follows the latter. The advantage in this case is more the convenience of handling than avoidance of distortion, since draw temperatures are not high enough to cause serious loss of straightness.

Results Obtained

As mentioned earlier, distortion in the heat treatment of light plate or sheet is not a new problem to the engineers of E. C. Atkins & Co., who have always had to fight it in the manufacture of high-grade saws. Thus (they point out) there are types of distortion that cannot be prevented by the pressure quench. For example "green" plate is often received from the steel mill that *looks* flat but which actually is longer along the edges than down the middle (usually because it was rolled on the same mill and with the same rolls and crowns used on heavier plate); such plate has a wavy edge after treatment and must be subsequently worked in stretcher rolls that stretch the plate where it is short. This is an art at which sawsmiths are proficient.

But aside from this, Atkins estimates that the Drever pressure quench units in their shop have saved up to 75 per cent of the straightening work normally performed, as judged by their own subcontractors' experience. Some straightening is necessary, but not on all the work, much of the production requiring none. Part of the straightening that is done, too, might be omitted by other companies.

All of Atkins subcontractors use spray-quenches and must straighten their plate before fabricating it, at an estimated total cost of $15,000 per month. Such straightening expenditures are saved by Atkins through their use of a pressure quench. Plate that they fabricate after heat treatment is in most cases sufficiently straight as it leaves the pressure-quench; plate that must be fabricated *before* treatment is furnace-flattened and annealed by Atkins to a uniform workable condition (about 200 Brinell).

Atkins employs a total furnace force (for the two continuous armor-plate-treating lines) of 4 men—2 loaders, 1 operator and 1 assistant operator. The Brinell operators unload and stack the plates as they come off the line.

The extent of the straightening-time saving is represented by this simple case: Among the armored-vehicle parts that Atkins makes is a door that must fit *perfectly*. A typical batch of these doors will pass inspection with only 40 per cent requiring any press work to perfect the fit. But even when 100 per cent of a batch of doors must be smithed, the overall straightening time and cost are still but 25 per cent of their amounts when the plate for the doors is spray-quenched rather than pressure-quenched.

WARTIME ENGINEERING ACHIEVEMENTS

Electrotinning and Its New Position

A major achievement of America's steel industry for which the industry only seldom receives public credit is the tin-saving revolution it has effected through the development, installation and operation of continuous electrolytic tinning lines to replace hot-dipping in the manufacture of tinplate. Associated with the steel companies in this development have been the can makers, electroplating equipment and supply manufacturers, and the electrical equipment companies. The engineering elements of this cooperative achievement of American industry are presented herewith, with an appraisal of electrotinning's position today — and tomorrow. —*The Editors*

By FREDERICK A. LOWENHEIM

Research Chemist, Metal & Thermit Corp., Rahway, N. J.

AS WITH SYNTHETIC RUBBER and other new developments, the maturity of the electrotinning program was greatly hastened by the war, which had the effect of telescoping into months the orderly progression of research, development and pilot plant which in normal times would have required years instead. When the principal sources of tin ore in the Dutch East Indies and Malaya fell into enemy hands, electrolytic tinplate was a promising but still highly experimental new development.

The U. S. Steel Corp. at its mill in Gary, Ind., had been producing "Ferrostan" for about 5 yrs.; the Crucible Steel Co. of America had been in production on "Crutin" for about the same length of time; and the Crown Cork & Seal Co. had started an electrolytic tinning line at its Baltimore plant. These were full-scale lines — *i.e.*, they accommodated strip of widths of 20 in. or more.

Narrow pilot lines had been installed by the Weirton Steel Co. in cooperation with United Engineering & Foundry Co. and Hanson-Van Winkle-Munning; other plans were undoubtedly in the blueprint stage. The can-making companies had begun a well-planned long-range testing program to determine the uses and limitations of electrotinplate bearing a lighter coating than the conventional hot-dip plate.

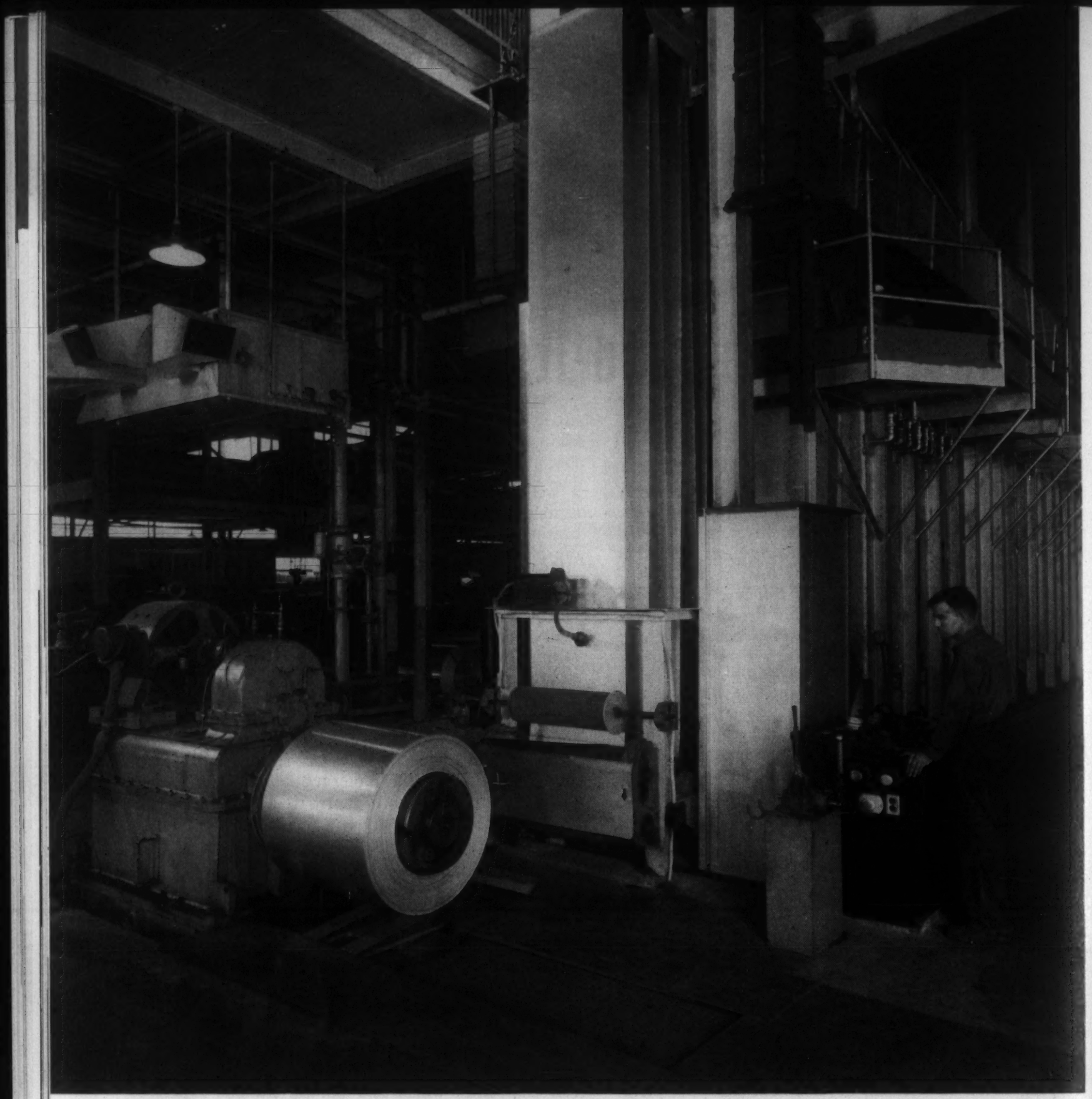
The Growth of Electrotinning

Ever since cold-reduction methods supplanted hot-rolling for the manufacture of tinplate stock, the attractiveness of treating the resulting continuous coils as a unit instead of shearing them up for tinning has been evident. Experiments in continuous hot-dipping of coils had met with little success; the electrolytic method, however, showed promise. The fact that the quantity of tin applied to the steel was susceptible of much more rigid control electrolytically than by hot-dipping was also of interest. The installations mentioned above were thus logical outgrowths of the cold-reduction process.

But the tinplate produced electrolytically before 1942 rated hardly more than a footnote in annual tables of production, and all of it went into specialty items rather than into so-called sanitary cans, *i.e.*, food containers. When it became imperative to stretch to the utmost our limited supply of tin, those specialty items immediately felt the WPB's axe. But the electrotinning processes were available to coat more steel with less tin; the can companies rushed their experimental testing program; those steel companies which had not carried out experimental programs of their own hastened to buy or license one of the several existing processes. By the end of 1942 electrotinplate had risen from a negligible proportion to about 3 per cent of total tinplate production; in 1943 the use of electrotinplate will have grown to 15 or 20 per cent, with much higher percentages predicted for the future.

This has meant a major revolution in the tinmills of the steel companies, even in those such as Carnegie-Illinois which had 5 yrs'. background of experimental work and production. And how much greater is the revolution in those companies which had taken little or no part in the new development. Electrochemists are, as a rule, unusual in a steel mill; many metallurgists, engineers, and foremen had suddenly to learn the new language of current densities, cathode efficiencies, polarization, and such.

For the can companies, too, electrotinplate has



Exit or delivery end of an electrotinning line. (Courtesy: The Crown Cork & Seal Co.)

meant some fundamental changes. The lighter coatings made possible by electrolytic tinning do not have as good corrosion resistance as the heavier hot-dip coatings. Cans made from the new material must be lacquered to improve their protective quality. Problems arose in connection with the adhesion of the lacquers. No longer could the leisurely testing of packs over a one, two, or three-year period be relied on: New and faster methods to determine the suitability of the electrotinplate for various foods had to be devised. (For an excellent review of the can makers' problems, see "Electrolytic Tinplate from the Can Makers' Point of View" by K. W. Brighton, presented at the October, 1943, meeting of the Electrochemical Society).

The steel companies and the can companies worked together to solve the problems connected with product quality, such as lacquer adhesion and solderability. Electroplaters: Hanson-Van Winkle-Munning, duPont ("Halogen" bath), Metal & Thermit (potassium stannate bath) developed new or improved tin-plating solutions, particularly adapted to the special requirements of continuous line plating vs. the conventional job-plating setup. Equipment manufacturers: United Engineering & Foundry, Wean Engineering, and many others developed specialized handling apparatus. General Electric contributed newly-designed rectifiers for plating power. Westinghouse adapted the principles of electronic induction heating to the problem of reflowing the coat-

Electrolytic Tinplate Lines at the End of June 1943

Type of Process	Company	Number of Lines		
		Operating	Building	Est. Completion Date
Acid Solution	Crucible Steel Co.	1	0	
	United Engineering design:			
	Weirton Steel Co.	2	1	July, 1943
	Republic Steel Corp.	0	2	July-Aug., 1943
	Carnegie-Illinois design:			
	Wheeling Steel Corp.	1	0	
	Carnegie-Illinois Steel Corp.	4	3	July-Sept.-Nov., 1943
	Tennessee Coal, Iron & Railroad Co.	1	2	July-Oct., 1943
Alkaline Solution (All lines designed by Crown Cork & Steel Co.)	Crown Cork & Seal	1	0	
	Bethlehem Steel Co.	2	1	July, 1943
	Youngstown Sheet & Tube Co.	2	0	
	Granite City Steel Co.	1*	0	
	Jones & Laughlin Steel Corp.	1	1	July, 1943
	Inland Steel Co.	2**	0	

* on dull finish
** one line on dull finish

ing after the plating step. As in many other fields, American industry proved that it could cooperate to do a job.

As a result, America's tin situation is not as critically dangerous as it might otherwise have been: (Credit for this goes also, of course, to the Government for its stock-piling program and the Texas smelter; to the conservation of tin in its other uses; and to the not inconsiderable efforts of the detinning companies). The electrotinning program is considered to be well enough advanced so that the WPB is gradually increasing the mandatory use of electrotinplate and restricting the permissible uses of hot-dip. After an all too short youth, the electrotinning program may be said to have grown old enough to fight.

Processes in Use

Electrotinning lines at present in production may be divided into two general classes: Those using acid electrolytes and those employing alkaline electrolytes. Further subdivisions of these two classes will be mentioned later. The status of electrolytic tinplate lines at the end of June, 1943 was summarized by *Iron Age* (June 24, p. 94) as in the accompanying table. It may be assumed that the lines scheduled for completion in July and August are now operating.

While the mechanical and electrochemical features of the various tin-plating lines differ in many respects, the fundamental flow-sheet is similar for them all. The coils of strip are received at the entry end of the line annealed and temper-reduced. They are picked up on uncoilers which feed the line; there are usually two of these, so that in connection with an automatic seam-welder the operation of the line can be made continuous. Following this is a looping pit or tower, to maintain some slack which provides for operation of the line during the short time it takes to weld on a new coil. Thence the strip enters the pickle tank, where dilute sulphuric acid plus inhibitor at about 150 deg. F. etches the surface and removes the oxide film. Provision may also be made for electrolytic alkaline cleaning, on some lines.

The pickle liquor is rinsed off in a rinse tank, and the strip then enters the plating tank. The strip passes over contact rolls, which serve to introduce the plating current; in some lines (Crown alkaline, Carnegie-Illinois) the strip moves in a vertical serpentine manner, over contact rolls above the bath, under rubber rolls placed at the bottom of the tank; in others (United Engineering) the movement of the strip is horizontal over the top of the plating tank, with the contact rolls above it, only one side of the strip being plated at a time. Tin anodes are placed between the vertical passes of the strip (vertical type lines) or below the strip (horizontal type lines). Plating current is supplied by motor-generator sets or by copper-oxide rectifiers. (1, 2, 5, 14).

The length of the plating tank is determined by the current density which is used, the speed of travel of the strip, and the coating weight of tin desired. Once built, of course, the tank length itself determines the speed and/or coating weight at any given current density.

Finishing Operations

After plating, the strip enters rinse tanks which free it of adhering electrolyte, which is recovered as make-up; it is then dried, usually by a blast of hot air or steam or both. In this condition the strip has a semi-bright, satin-like finish which is acceptable for some uses, but is rather soft and easily marred. Because of the superior appearance and corrosion resistance of the reflowed plate, the can companies today require that the tin coating be melted, an operation which produces a mirror-like finish, indistinguishable except by the eye of an expert from hot-dip plate.

For this purpose the strip passes to the heating unit, where it undergoes the operation variously known as brightening, reflowing, and melting. The heat necessary for this operation may be introduced

A high-frequency induction unit used for reflowing the surface of electrotinplate to improve its appearance and protectiveness. (Courtesy: Westinghouse Electric & Mfg. Co.)

in a number of ways: By hot oil, gas burners, resistance, radiant tube furnace, or induction. The last-named appears at present writing to be the most popular.

After reflowing, the strip is quenched, usually in a chemical bath designed to improve the surface characteristics with regard to lacquer adhesion or solderability. After drying, the delivery end of the line is reached, consisting of looping pit or tower, and wind-up reel. The function of the looping pit is similar to that of the one at the entry end: To allow for operation while one coil is being slipped off the reel, the weld cut out and another coil being started.

In some installations a shear is placed in the line instead of a wind-up reel, so that the strip is delivered already sheared to size. In some cases the reflowing step is omitted, and carried out in a separate line; while this involves duplication of apparatus and additional handling, it is claimed to make for increased flexibility of operation. Other modifications include the insertion in the line at appropriate points of oilers, branners, brushes, degreasers, etc. (1, 2, 5, 14).

Present electrotinning lines are designed for strip speeds of 300 to 500 lineal feet per minute, although up to 1000 ft. per min. is considered a possibility. Speed will depend to a great extent on the coating weight applied; although most electrotinplate now carries 0.5 lbs. of tin per base box, the trend is to heavier coatings; experiments have been initiated on the use of 0.75 lbs. for evaporated milk cans.

The mechanical and electrical problems connected with feeding, guiding, and pulling the strip at constant speed over the many rollers necessary for the operations above described are numerous, and their solution represents a triumph of engineering ingenuity. The metallurgists, too, are kept busy, for problems of steel quality are, if anything, more exacting than with hot-dip tinplate. Good descriptions of the mechanical features of the lines are available in the literature and will not be repeated here (see Bibliography, references 1, 2, 4, 5, 13, 14). A few notes on the electrochemical aspects may, however, be in order.

Bath Types

As stated, electrolytes in use may be divided into two general classifications: Alkaline and acid. Alkaline baths include the sodium stannate-acetate solution, based on the Oplinger and Wernlund patents[8, 9];

and the recently introduced potassium stannate bath of Sternfels and Lowenheim[12], which is believed to be an improvement over the sodium stannate bath in several respects. Acid solutions now in use are: The newly-introduced "Halogen" bath of duPont, concerning which no details have been published; the tin cresolsulphonate solution based on the Schloetter patents[11] used by Carnegie-Illinois; and the stannous sulphate-sulphuric acid bath, based on patents to Fink and to Hopper[3], used by the Crucible company.

All the acid baths have in common the features that tin is plated from the stannous (bivalent) condition; they are operated at or near room temperature; and they require the presence of a closely-controlled quantity of addition agent of organic or colloidal nature for the production of satisfactory deposits. On the other hand, the alkaline solutions contain tin in the stannic (quadrivalent) form; they are operated hot (80 deg. C., 176 deg. F., or above); and they are, or may be, extremely simple in composition, requiring no addition agents and consisting merely of the alkali metal stannate, the corresponding hydroxide, and water, plus carbonate as an unavoidable but non-deleterious impurity.

Since the urgency of the situation forced the steel companies to decide on the choice of an electrolyte hurriedly, before one bath or the other had had the opportunity to prove its definite superiority; and since the choice of electrolyte to a great extent dictated the design of equipment, it seems likely that the five solutions enumerated will all continue to be used for some time, except in the unlikely case that one particular electrolyte proves to be so overwhelmingly superior in operation and economy that all users will be obliged to convert. Further, the various acid installations may be adaptable to any one of the acid solutions, and the alkaline lines are adapted to the use of either the sodium or potassium stannate bath. Discussion concerning the relative merits of the various solutions has been, and gives promise of continuing, lively.

Acid vs. Alkaline Baths

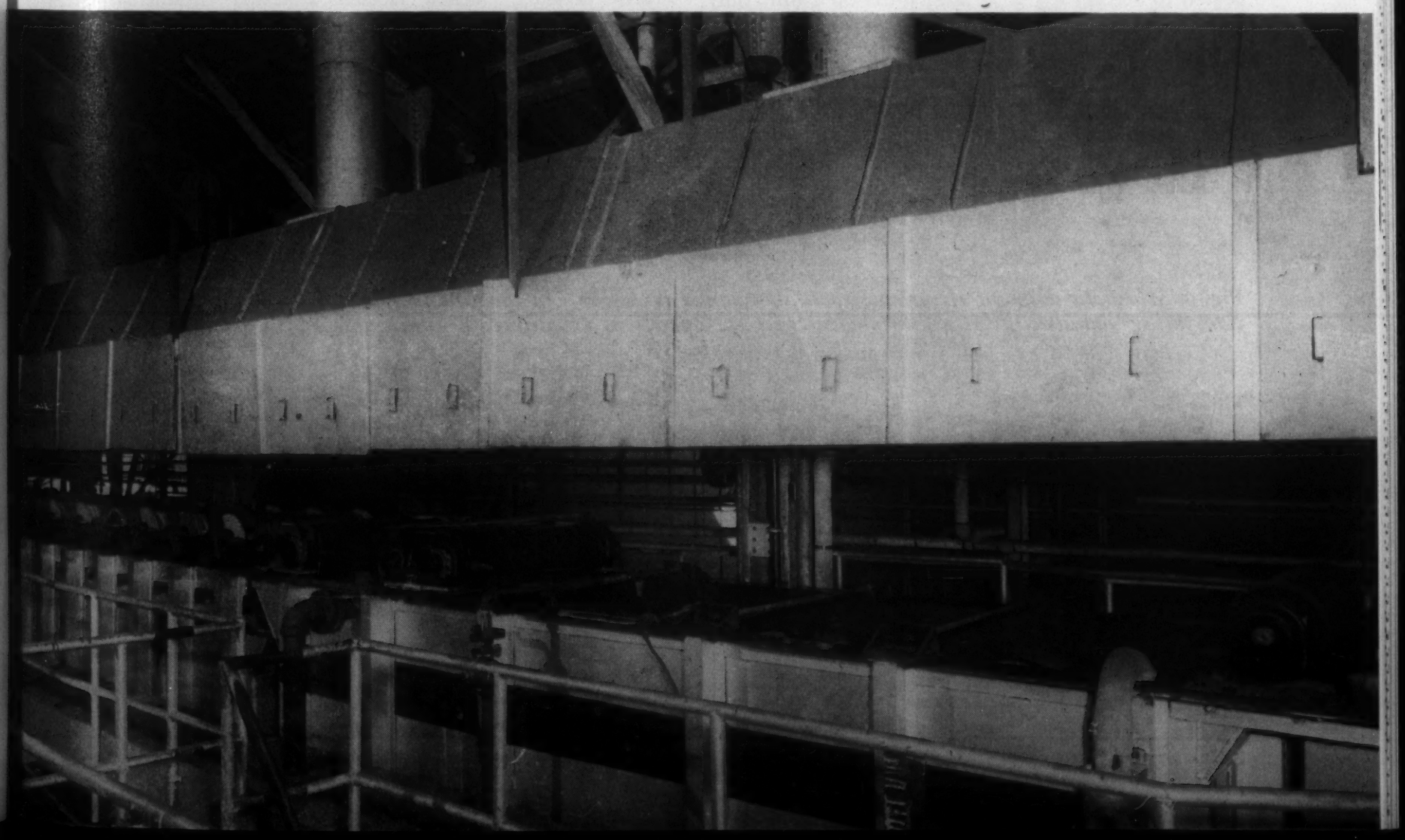
The principal arguments center around speed of operation. Since the tin in an acid solution has to be reduced only two valences, while four valence changes are involved in the alkaline solution, a given number of ampere-hours will deposit twice as much tin from an acid bath as from an alkaline. Further, current efficiency is in general higher in the case of the acid bath (95-98% vs. 82-90%); and finally, higher current densities may usually be employed with some of the newly introduced acid baths than with the sodium stannate solution. On the other hand, the potassium stannate solution shows promise of possibly matching the current density employable with the acid electrolytes.

The advantages of the acid bath above outlined add up to higher production speeds with a given current capacity and tank length; because speed of strip is related to the other variables in this fashion:

$$S = KAE/CV$$

where S is speed of strip, feet per minute
E is current efficiency
A is total amperes
C is coating weight of tin
V is valence change of tin
K is a constant depending on strip width, equivalent weight of tin, and physical constants.

Entry end of the pickling tank with part of the plating tank visible. (Courtesy: The Crown Cork & Seal Co.)



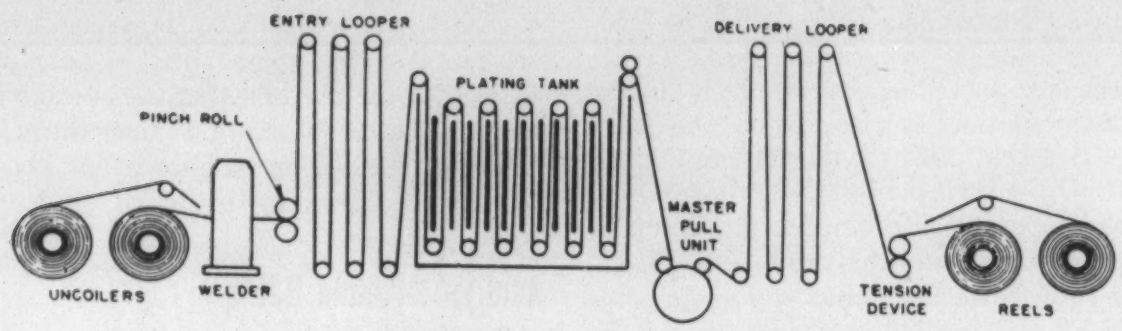


Fig. 3. Schematic diagram of a constant plating speed, vertical tank line. The steel sheet is wound in a tight coil up to 36 in. wide and three miles long. This strip is threaded through the electrolytic tinning tank and on to rewind rolls. (Courtesy: Westinghouse and "Metal Finishing")

Also A = D F, where D is the current density, amperes per square foot, and F is area of strip in tank, square feet. Consequently, where D may be large, F may be small — *i.e.*, a shorter length of plating tank, requiring fewer contact rolls and less solution may be employed. The alkaline setup, in order to attain speeds comparable with acid lines, utilizes a much longer plating tank and more contact rolls.

But the alkaline solutions have many favorable factors to oppose to these disadvantages. Anyway, say the alkaline proponents, power cost is a very minor factor in the overall production figure.

All acid solutions require very close control of the organic addition agent to produce an acceptable deposit, and this control may pose a rather ticklish problem. Stannate solutions, by contrast, are extremely simple in composition, and furthermore, will produce an acceptable deposit even if the composition is allowed to deviate widely from the optimum, provided only that the anodes are properly filmed. For this reason the alkaline solution has appealed to some for use in steel mills on 24-hr. duty, where for two-thirds of the time expert guidance may not be available.

Cleaning of the strip is much less of a problem with the alkaline bath, for the plating solution itself is an excellent detergent, being strongly alkaline and hot.

Alkaline stannate solutions have far better "throwing power" than the acid baths. The term "throwing power" is a much-abused one; and in connection with perfectly flat cathodes there is some doubt if it has much meaning. However, the proper adjustment of anode width to the width of the strip being plated is more critical in the acid electrolyte.

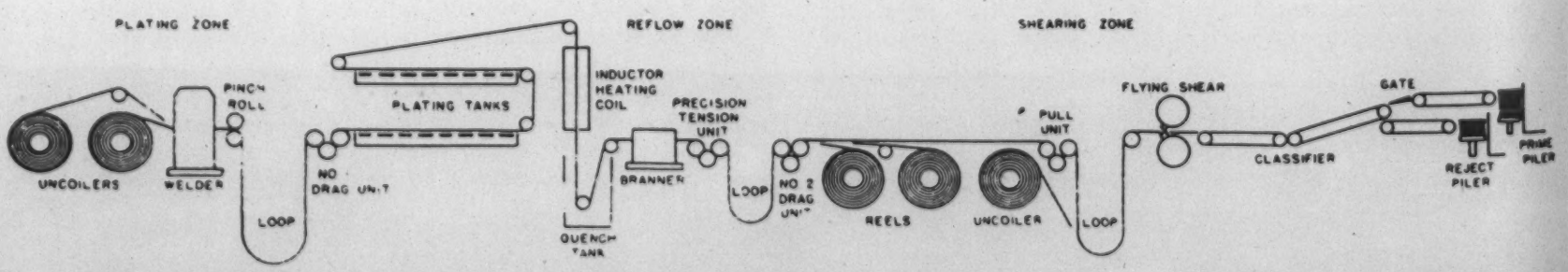
Finally, alkaline solutions are non-corrosive and do not require rubber-lined or other corrosion-resisting equipment.

Some Special Problems

The final criterion of choice among the various electrolytes might be thought to be the quality of the product. For some time the solderability of the alkaline plate was thought to be superior to that of the acid; by dint of much research a chemical treatment, involving chromate solutions, was found which largely or completely removed this objection to the acid product. When lacquer adhesion became a factor, the tables were turned: The alkaline plate was much inferior to the acid. But again, careful and painstaking work developed surface treatments for the alkaline plate, and once more the products seem to be about on a par.

The acid installations in general operate with current densities of 100 to 300 amp. per sq. ft., at effi

Fig. 4. Schematic diagram of variable speed, horizontal tank line. In this line the electrolytic tinning, induction fusing and sheeting is a continuous, complete operation. (Courtesy: Westinghouse and "Metal Finishing")



ciencies which closely approach 100 per cent. Not very much looping-pit capacity is provided for, since the strip may be slowed down when it becomes necessary to weld on a new coil; the speed may be automatically tied in with total current, so that the coating weight remains the same.[2]

The sodium stannate solution is generally run at cathode current densities of about 35 amp. per sq. ft.; to compensate for the lower density, much more strip is immersed in the longer tank, so that operating speeds are about the same as with the acid baths. Looping-pit capacity is larger, because of a peculiarity of the stannate bath: If anode current density is decreased too far (as during a slow-down), the anodes lose the yellow film which forms during proper operation, and the anodes dissolve as stannite (bivalent). Even a small amount of stannite in a stannate bath produces a spongy, inferior deposit. Thus the speed of the strip must be kept nearly constant, and the looping-pit must store much more slack.

The potassium stannate bath is capable of much higher cathode current densities than the sodium stannate solution. It is also much less susceptible to hydrolysis, and the attendant precipitation of insoluble tin salts. The bath is a newcomer to the field, and is being used by one major producer as well as in a pilot line. The progress of this electrolyte is being watched with interest by other users of alkaline solutions; if the trend to heavier coating weights continues, with the attendant slowing-down of lines limited by the relatively low current densities usable with the sodium stannate bath, the potassium stannate solution should find a ready field.

(The author must point out in all fairness that he has an interest in the potassium stannate bath.)

Is Electrotinplate Here to Stay?

What about electrotinplate vs. hot-dip? For the duration of the emergency, when saving of tin is a primary consideration, there can be no question of the value of the lighter coatings made possible by electroplating; for hot-dipping techniques have never succeeded in producing an acceptable plate carrying less than 1.25 lbs. per base box, whereas electrolytically it is obvious that the coating weight may be made as light as desired. In conjunction with lacquer, electrotinplate carrying 0.5 lbs. per base box seems to perform satisfactorily and saves many tons of tin.

When tin once again becomes plentiful, however, it would appear that there will be decreased use for 0.5 lb. plate except possibly for dry-packs or specialty items—a field which may be open to invasion by substitute materials like plastics, Bonderized steel, etc. Lacquered half-pound plate has little if any economic advantage over plain hot-dip with 1.25 lbs. of tin. Electroplating, however, does away with the drip or list edge of hot-dip; it handles continuous coils instead of individual sheets; and it applies a much more uniform coating. For that reason some argue that one-pound electroplate may be equivalent in corrosion resistance to 1.5 lb. hot-dip, although this is by no means proved.

Nor should the possibility of applying composite coatings electrolytically be lost sight of. With the experience gained in the electrolytic processes during the war years, and the large investments (of the order of $1,000,000 per line or more)[5] tied up in electrotinning lines, it seems very unlikely that electrotinning will be abandoned. Some enthusiasts expect that it will completely supersede the hot-dip process. To these enthusiasts, the word of caution from *Tin* for June, 1943, is in order:

> ". . . electro-deposition is a convenient means of applying a thin coating of tin which gives a product of considerable utility. Its adoption has in consequence been greatly stimulated by the present tin shortage. It is not, however, a magic process which enables 0.5 lbs. of tin per basis box to provide the same protection as is given by 1.5 lbs. of tin."

The steel industry has again proved its ability to rise to an emergency; and as usual, has done things on a grand scale. The tinning lines of the industry are capable of plating with tin almost 2 square miles of steel per day. Put another way, the coils of steel plated every day by the combined lines of the tinplate industry, if stretched out in approved statistical fashion, would reach across America. Certainly the *effects* of this tinplate revolution will reach across America.

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WARTIME ENGINEERING ACHIEVEMENTS

Post-War Planning in the

When this war is over and the accomplishments of American industry are being appraised with more detachment than is now possible, one achievement that will receive a large share of grateful attention will be the post-war planning job that our manufacturers did without decelerating the war production program in the slightest measure. Extra time at night, week-end moments, fitful study on trains, luncheon discussions, even a little quiet dreaming at the break of day — these were all the allocations of time some men could muster for the purpose. Yet the results achieved will some day be seen to have been epochal in fashioning the cornerstone of this country's industrial World of Tomorrow.

In this important article Mr. Knight reports on the status of post-war planning in the metal industries, as he found it in a just-completed survey of several hundred large and small manufacturers of metal products. Some significant and possibly startling conclusions can be drawn from the information they provided.

—The Editors

By HAROLD A. KNIGHT
News Editor

IF THE AVERAGE INDUSTRIAL PLANT that uses metals as the chief raw material should have a one-man post-war planning committee, it would be the sales manager. Make it two, and the head of engineering would be added. Call it a trio, and the third man would be a toss-up between an administrative executive such as the president or vice president, and the production manager. Further additions, in the order named, would be the research head; the general manager; the development, or market research, or business extension head; the treasurer or controller; the advertising manager, the design engineer.

Apparently the average manufacturer is going to use most of his present machinery, at least 90 per cent of it, for peace time purposes. Many have been keeping their machinery up-to-date during the war and there will be no marked replenishment in early post-war. Mr. American has learned much from the speed, precision and streamlining of war production which he will use in peace time, particularly as to close tolerances. He expects that present female labor is temporary and that only about 30 per cent will remain in post-war.

These and many other post-war plan-o-graphs, so to speak, have been learned through several hundred questionnaires sent out by METALS AND ALLOYS to typical large and small metal fabricators and producers throughout the country. Letters were written to company presidents by name. The percentage of returns was very gratifying and, even after this article is written, more are trickling in. Twenty-one questions were on the list under topics of: "Overall Planning," "Products Manufactured," "Raw Materials and Processes," "Machinery and Equipment," "Labor and its Utilization" and "Your Opinions on Politics, International Relations, Industrial Trends, etc."

Purpose of the Survey

Much has been written on the subject, with a plethora of pretty pamphlets in gorgeous language. It is fairly well known by now that Henry Kaiser plans to build Flying Wings that will bring broccoli from Texas to New York's dinner tables—24 hrs. between fields and tables; that Kaiser will build railroad trains of light metals of half the present weight; that electronics will toast frankfurters at the hot dog stands, cooking them from the inside out, before the blase eyes of the roadside customer; that Mrs. Every Housewife will have a quick freeze refrigerator in her kitchen so that food will taste as fresh in December as it did in May.

What the editors of METALS AND ALLOYS wished to ascertain were the plain, unpretty facts about what the average manufacturer is actually thinking, planning and executing along lines which would interest our readers. We believe the results were as satisfactory as could be expected.

One president replied he had answered the questions outside working hours. Another wrote his company had resolved to throw such questionnaires into the waste basket but would make this the one exception. Another replied that he had just read our "very interesting questionnaire." We feel those who answered benefited themselves. It helped them formulate their own thoughts, vague in spots, no doubt. Usually replies were 100 per cent complete, showed thought, keen analysis and a certain relish for the task.

Naturally, post-war planning starts with the appointment of some formal committee. More than twice as many companies have definite planning committees as those that do not. Besides the usual officials on the average committee, as mentioned in our opening paragraph, chairmen of the board are members in a few cases, as are an occasional metallurgist, economist and purchasing agent. This committee or staff reports direct to the president in perhaps 70 per cent of the cases; otherwise to the general manager, vice president and, in rare cases, to the directors, secretary, treasurer, or to a "merchandising board."

Metal Industries—A Survey

One of the early questions was: "What per cent of your technical research is earmarked for post-war?" Averaging these percentages, from 0 to 100, we get 39.7 per cent. Of the total who answered this question, 17.50 per cent have assigned their research staff 100 per cent to post-war problems.

Will Post-War Products Be Different?

Will your post-war products be the same as your pre-war products?

Here 15 per cent of the replies were "No." Perhaps the executives took the question very literally. Perhaps the question should have been asked: "Basically the same?" The typical answer was: "At least 75 per cent the same, with all improved and streamlined." In the same vein was: "Yes, with some redesign to bring up-to-date." A progressive-minded president answered: "Yes, with continuous changes and improvements." Another open-minded executive answered: "Research may develop new products before the war ends, or afterward."

A large aluminum manufacturer stated: "We have expanded in character and scope and improved in utility to the user. We have since the war become a fully integrated aluminum producer and fabricator from bauxite right through to aluminum parts. This will be a new division after the war."

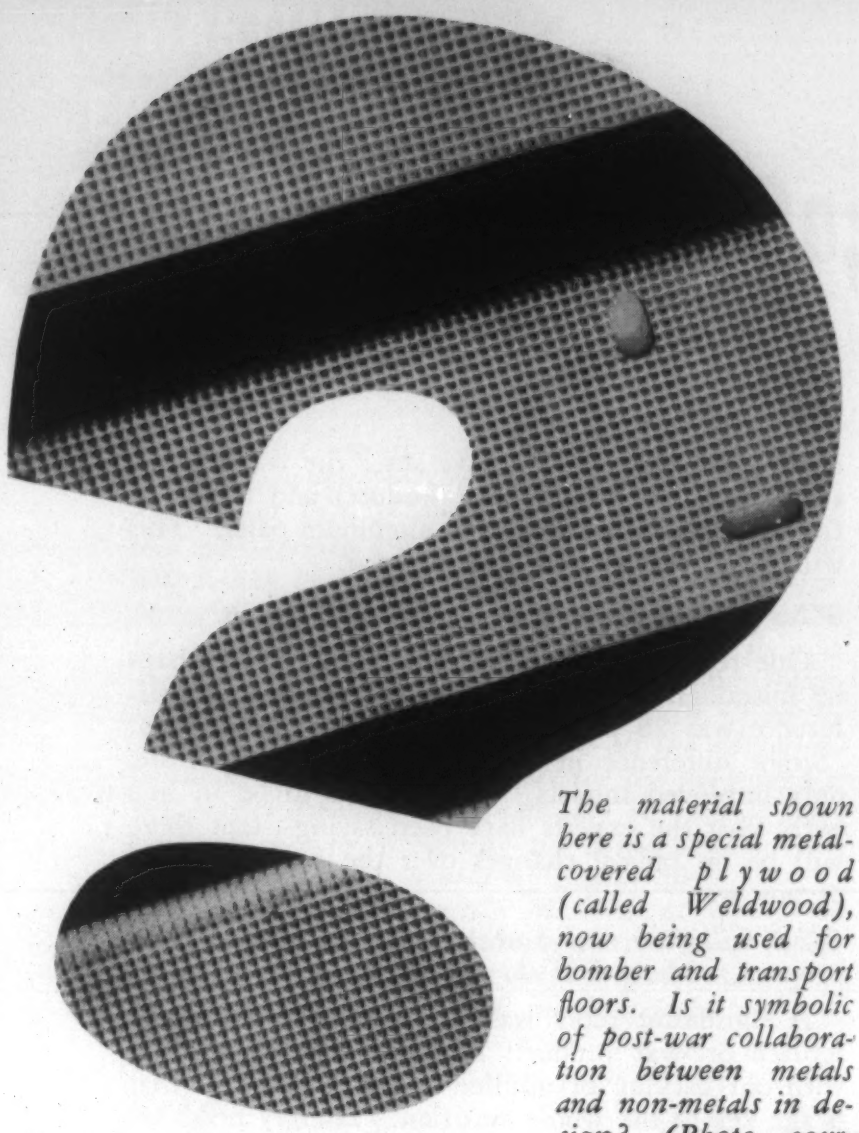
What per cent (of products) will be different?

One reply was "100 per cent different"—perhaps he misunderstood the question for the average difference was 20 per cent. The typical answer was: "Slight difference in design only," or "very little, only improved models." This seems to be in line with what the experts have been saying—that there will be no radical changes over the first two years of post-war.

What will your new post-war products be and what pre-war products will they replace?

A significant reply was: "Post-war products will replace pre-war products after we have caught up with our backlog of unfilled orders." Perhaps that is the key to the whole situation. Hungry needs of civilians will first be satisfied, with competition low. Later, with first demands satisfied, it will become a buyers' market and then producers will really compete with new and fancy products. "New products

Here is a typical triple-barreled post-war question-mark, brought about by wartime developments: Female labor employed to braze carbide tips (the war has tremendously boosted the use of carbide tools) to steel shanks, using electronic-type induction heating. To what extent will these three (female labor, carbide tools, induction heating) continue in wide-scale use after the war? (Photo courtesy: Carboloy Co., Inc.)



The material shown here is a special metal-covered plywood (called Weldwood), now being used for bomber and transport floors. Is it symbolic of post-war collaboration between metals and non-metals in design? (Photo courtesy: United States Plywood Corp.)

will involve considerable diversification with respect to former lines," answered one.

The general consensus was that no products would be replaced, but merely added to in number. Thus a steel maker replied: "In the case of our special purpose iron or steel sheets, plates and strip, there will be additions rather than replacements." During the war we have had to be slaves to standardization, few sizes and shapes. An orgy of diversification may follow. A maker of plumbing, heating and refrigeration supplies expects to take on "new alloys and additional new products." A maker of bicycle equipment, such as lamps, horns, etc. plans "molding of plastics for the general market." A producer of hand tools has used hot extrusions during the war and will make his regular line partly by that method.

Some manufacturers will court new outlets. A maker of heavy duty tools and equipment will try to enter the airplane industry for the first time, having previously catered only to railroads. A maker of fastening devices states: "A new industry, airplane, will be added to our customers. Probably for two years there will be but few changes over pre-war in the mass production industry"—again, a leading, oft-expressed idea.

Will your post-war products more closely resemble your war, or pre-war products?

On second thought, perhaps this question should not have been asked for it is obvious that war is war and peace is peace and "seldom the twain do meet." At any rate the answer was overwhelmingly: "Pre-war." In some cases the answer was "both" for many makers continue in war what they made in peace, products such as valves, one of the critical components of recent months.

Changes in Materials, Methods, Machines?

Will there be important or drastic changes in your raw materials (pre-war vs. post-war)? Can you be specific?

About 75 per cent replied: "No," or "No drastic change." However several of the "moderns" came in for favorable votes. A maker of fastening devices replied: "Light weight non-ferrous metals may replace brass. Steel will pretty well hold its position because of its strength. Plastics will expand, but in new products." Steel had another friend, maker of hardware, tools and strip steel, who said: "Steel will be paramount, though we may increase the use of non-ferrous metals and plastics." And another, who said: "Steel will be major as before, but we will also use large quantities of non-ferrous metals, plastics, impregnated plywood, etc., we being makers of sheet metal shelving, lockers, chairs, etc."

A New England manufacturer will use more light metals, synthetics and plastics. A maker of refrigeration and air-conditioning equipment will use more aluminum and magnesium. A producer of pipe and fittings for plumbing, heating, air-conditioning and refrigeration will use the same materials as before plus "new such as aluminum, magnesium, steel and cast iron." An aircraft manufacturer expects that 25 per cent "will embrace new types of raw materials." Said another manufacturer: "National Emergency steels have taught us much about eliminating alloys with improved heat-treatment technique—Why go back?"

Similarly, will you have changed to different fabricating processes, once unfamiliar or slightly used? Which process then and now?

Here 90 per cent plainly indicated that they would not change. Five per cent said "yes" and another 5 per cent, "partly." A maker of canning machinery, packing house equipment, etc. stated: "New war tooling has enabled us to use new methods." A maker of metal office furniture stated they would do more assembly work. A manufacturer of copper, brass and aluminum tubes stated they would make some changes in fabricating processes. A maker of clocks will do more grinding. A maker of equipment for bakeries and for chemical and industrial fields "will change fabricating processes, using more sheet metal fabrication and fewer castings." Another will do more electric welded work. Another expects about 15 per cent different fabricating process. One president of a hydraulic press manufacturing company said: "Much more special tooling for multiple production will be adopted permanently and will be expanded steadily."

Will wartime influences, such as production speed-ups, lightweight, closer tolerances, improved finishes, streamlining, etc., markedly affect your post-war pro-

duction or design? Can you cite the most important specific influences in your case?

Apparently the most common improvement has been ability to manufacture to closer tolerances. One company lists they have learned "tolerances and finishes"; another, "tolerances and light weight alloys." A rather smug manufacturer states: "We will incorporate no changes—we always have made extra quality." Another rather self-satisfied producer states: "A gradual change goes on continuously. No marked change of startling importance has been made, or expected." (Yet a gradual change often becomes a marked change when the present is compared with sufficient period into the past.)

A maker of wrapping machines in peace and gyrocompasses for war is more enthusiastic, answering: "Decidedly. Before the war we made tailor-made equipment. We have learned how to apply production methods and have worked to closer tolerances." A producer of cooking and heating appliances writes: "We will work to closer tolerances and with better inspection methods." Another philosophizes: "Hot extrusions were new to us. We used them on ammunition projectiles. We will also use improved finish on our hand tools." One suggests: "We have learned conservation of critical material." (But will that be necessary after the war?) For one maker, "the most important development for us was experience gained in fabrication of non-ferrous metals." Another comments: "War time influence has depreciated the appearance factor as to painting, chrome plating, shields and covers. These will be restored."

Some answered "yes" or "no" without comments. There were 11 "yeses" to every 8 "noes."

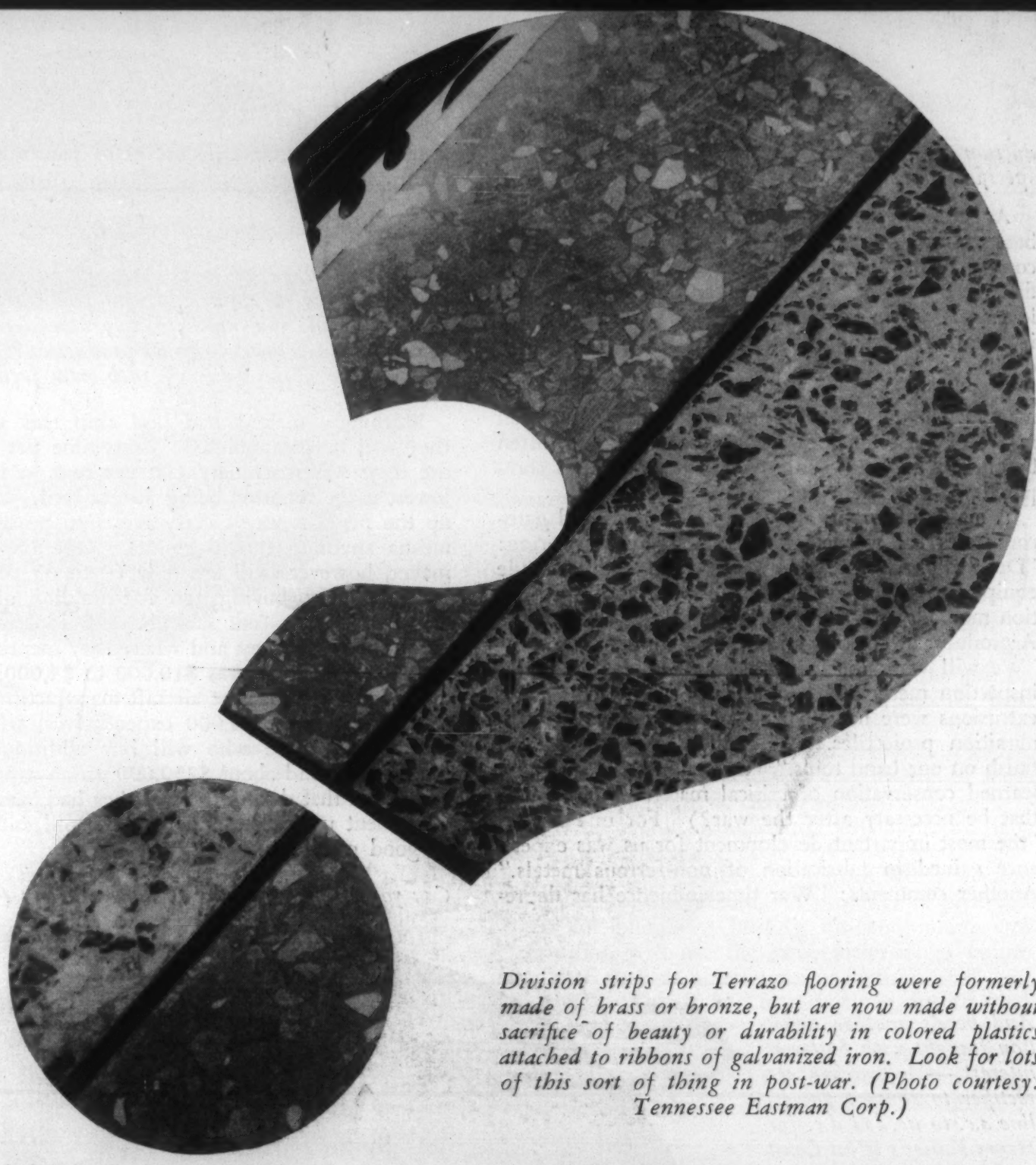
What percentage of your present machinery and equipment can be applied to your post-war manufacturing? Will you need to buy considerable new equipment to convert to peace-production? Can you estimate the dollar-value of such new facilities?

Machinery makers had best skip this section as they will be disappointed. Sixty-nine per cent will use their war machinery 100 per cent in peace, the lowest usage reported being 30 per cent. Averaging up the percentages of carry-over into peace (if that means anything), 92.6 results. One bicycle lamp maker, however, will use only 60 to 65 per cent of old machinery, buying new for molding of plastics.

About 20 per cent said they would buy "much" additional equipment and where they mentioned dollar value the range was $10,000 to $4,000,000 (the latter one of the largest aircraft manufacturers). Disregarding the $4,000,000 expenditures, which were not typical, those who will buy additional equipment will spend about $250,000 on an average. Several stated that during the war they had been keeping equipment up-to-date and hence would end the war in good condition.

Can you estimate how much more efficient (on a pro-

And here's another situation fraught with post-war interest — a mercury arc rectifier to convert power-line a.c. to needed d.c. for Henry Kaiser's West Coast steel mill. Mercury arc rectifiers are electronic devices whose use in the metal industries has expanded heavily during the war — will this expansion continue? And how will the West Coast steel industry fare in a "normal" economy? (Photo courtesy: General Electric Co.)



Division strips for Terrazo flooring were formerly made of brass or bronze, but are now made without sacrifice of beauty or durability in colored plastics attached to ribbons of galvanized iron. Look for lots of this sort of thing in post-war. (Photo courtesy: Tennessee Eastman Corp.)

duction per man-hour basis) your operations are than on Dec. 7, 1941?

We should have inserted "or less" after "more." The question was in the class of the famous cross questioner in court: "Answer 'yes' or 'no'—Have you stopped beating your wife?" At any rate a third were not led astray and answered "less efficient." It is possible that the two-thirds who noted either holding of own or increase in efficiency, either had more efficient, or same, help, and/or made their real gains in better engineering. An extreme case stated: "Is less efficient due to 200 per cent labor turnover." In one case, "increased efficiencies are probably offset by government red tape." A typical answer was: "About 15 per cent less efficient because of manpower shortage and green help." One said bluntly: "Twenty-five per cent less—people don't work." Extremes, as expressed in percentages, ranged from 50 per cent more efficient to 20 per cent less.

Labor Supply—Male and Female

What percentage increase or decrease in your working force, as compared with normal pre-war times, do you expect to occur in the post-war period?

By far the most optimistic was an aircraft manufacturer, stating: "Post-war employment will easily exceed pre-war by as much as five times." A maker of package machinery said: "We are 100 per cent over pre-war force and hope to keep it all." Forty-seven per cent expect increase in working force over pre-war; 18 per cent look for declines and 35 per cent for same numbers. Omitting the 500 per cent increase expectancy for the aircraft maker because it is too unrepresentative, the average expected increase among those who look for gains is 31.5 per cent. By strange coincidence, the average drop expectancy among the pessimists is 31.5 per cent. One president gave vent to a grouch when he remarked: "Our force was 20 per cent higher, but is now 10 per cent lower because of War Manpower Commission bungling and loss to the armed forces."

What per cent of your present female labor force will remain with you?

One realist remarked: "Not much—they are too good

looking" (No requests for address, please!). On this subject there were striking extremes. A piston ring maker remarked: "We hope all." Another wrote: "We expect to discontinue female force as soon as male services are available." A typical attitude, as expressed by a steel maker, is that where women worked before (probably inspection and sorting) they will work again. One explained: "Most of our female labor will gradually disappear due to seniority rules and re-employment of men from armed forces." Came one answer, with pen borne down upon for emphasis: "Heaven forbid—NONE!"

Do you expect to re-employ all of your former employees now in the armed services? If not, what percentage?

One terse reply proclaimed: "It is a requirement under the Selective Service Act." Most of the answers were an overwhelming "yes." "Yes, absolutely" was a typical statement. One enthusiast added: "Even if it means firing everybody else in the place." At the other end of the scale: "No, we expanded too fast before the war." Several suggested that seniority would govern. For a few who will hire only a percentage, the average was 36 per cent.

What hour-week do you think will be your average for the first 5 years after the war?

Here the vote was overwhelmingly, at least 85 per cent, for the 40-hr. week. Extremes were: 48 to 56 and "about 35." A company that makes food machinery and whose work may be seasonal suggested: "Forty-four hours part of the year, the balance 40 hours."

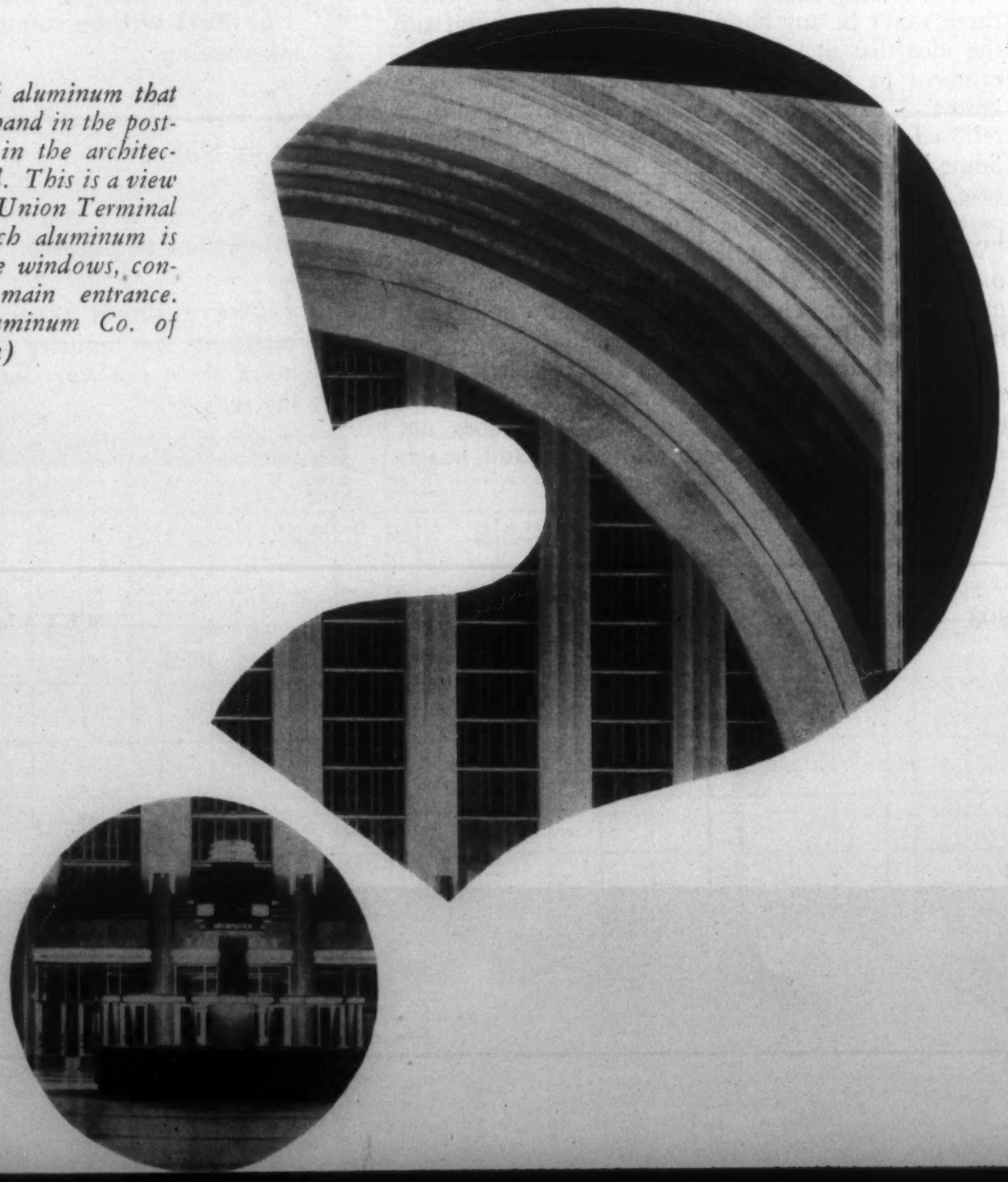
Do you believe industry will continue to be decentralized as it is now, or will it drift back to the old centers and populations of production?

Here the ratio was 2 to 1 in favor of remaining decentralized. One suggested: "It will be more decentralized in the future." One remarked: "Except for the Pacific Coast, industry will drift back to old centers." Another commented: "There will be a partial drift back due to closing of branch plants, etc." One opined: "We must operate nearer to centers of population to assure more flexible labor supply." Another favored continued decentralization because "it allows industry to take advantage of geographic locations and cut down transportation costs and delays."

Will labor-management relations improve, or otherwise?

Three out of four were optimistic enough to believe relations will improve. Many focused their searchlights on Washington for an answer. A typical opinion was: "Improve with a change of Administration; get worse, if unchanged." Several expect them to get worse and then improve. A few said in essence: "They've *got* to improve." One opinioned: "Will get worse because of unemployment." (But

Typical of the uses of aluminum that may be expected to expand in the postwar period are those in the architectural and building field. This is a view of the rotunda of the Union Terminal in Cincinnati, in which aluminum is effectively used for the windows, concession fronts and main entrance. (Photo courtesy: Aluminum Co. of America)



To what extent do you think the United States will help to rehabilitate the war-torn world?

Naturally this question set the stage for a field day of replies. Said one: "We should do a realistic, not an idealistic job." Another sputtered: "The present Administration will want to play Santa Claus to the whole world. The cost of such help will never be repaid. It wasn't in 1918."

Neither were the swear words spared: "Too damn much by Government and too little by United States business—and we imagine he slammed his fist on the table as he wrote. "Hell of a lot for awhile, then everything will turn *sour* when the U. S. awakens to the facts of human nature." Some of the more temperate answers were: "Probably more than advisable or practical"; "enormously—if the New Deal is in power they will go too strong on it"; "to give away our resources will gain us nothing—it all depends on 1944 elections."

A middle-of-the-ground commentator added: "We should assist nations to find the way back to peacetime pursuits and reasonable prosperity, but should not try to feed, clothe and educate the world." A skeptic answered: "Not to the extent of present publicity." A sensible president wrote: "Some help, but mostly in facilitating people to work out their own economic future." And here was a rapier thrust: "Yes, if left to Roosevelt; no, if left to better thinking minds."

Do you think your operations will be restricted or controlled by governmental interference? Does this possibility affect your present planning?

"Yes" answers to the first question were thrice the number of "noes." One plaintive comment was: "More control is in the cards. We are hoping and praying that this will be intelligent." One with venom in his pen in place of ink, replied: "If these New Deal experiments in running the show continue there won't be any business. We are planning with the idea that the American people will return Government to a sane administration." Another suggested: "This is a great uncertainty and should be relieved by some expression from Washington." Some believe that Government control will gradually ease. One pessimist opined: "Even more than in the past." Becoming specific one executive volunteered: "We believe that materials will be controlled for 6 months to a year after cessation of hostilities." One man with faith believes: "Fundamentally, individual initiative under capitalism will prevail."

As to whether this possibility affects present planning, the affirmative ruled over the negative 2 to 1. One rugged individualist put it: "This does not affect our present planning. Enterprise and imagi-

The conventional questionnaire invariably ends up with a space for "Remarks." However, our clientele were not very talkative. Outside of one complaint: "I don't believe this questionnaire will do any one any good," and another: "Send us a copy of your article," we drew mostly blanks.

Our own remarks are along the following line. Are we, the American people, again going to extremes? Are we making too much of post-war planning? When Studebaker changed from making wagons to automobiles, did he have elaborate post-wagon committees which got up charts, graphs, budgets, etc.? Or did he just do the natural thing of floating along with the tide?

Just the same, we believe in post-war planning—all kinds of intelligent planning, in fact.

SOME OF THE ANSWERS

AS REVEALED IN THIS SURVEY

1. **About 40 per cent. of today's technical research in the metal industries is earmarked for post-war.**

2. **85 per cent. of metal-industries plants will make approximately the same product as before the war.**

3. **Steel will lose little ground to the light metals and plastics.**

4. **War-production machinery will be largely converted to peacetime use, but there will be some new-machine purchasing.**

5. **Post-war employment is expected to be higher than pre-war.**

6. **Women are *not* here to stay as production employees.**

7. **Government regulation of and restraints on industry will continue—more than pre-war, less than during the war.**

Engineering File Facts

Aluminum Alloys

Types and Specifications

The system of designations used by the aluminum manufacturers is as follows: Number only — casting alloy; number and S — wrought alloy; number preceded by a letter — slight variation in composition; S4 — strain hardened; SO — annealed; ST — heat treatable; SRT — heat treated and strain hardened; SW — solution-heat-treated only; number following normal heat treatment designation — special heat treatment; T follow ing number — casting alloy, heat-treated.

SAE	Cu	Fe	Si	Zn	Mg	Ni	Mn	Temper	Ult. Str., 1000 p.s.i.	Yld. Str., 1000 p.s.i.	Elong., % in 2 in.	Hard. Brinell	Shear Str., 1000 p.s.i.	Fatigue Str., p.s.i. 5×10^8 cycles	Uses
Sand Casting Alloys															
—	8.0								22	14	2.0	65	20	7,500	General purpose castings
35			5.0						19	9	4.0	40	15	6,500	For leak-proof castings
37			12.5						26	11	8.0	50	18	6,000	Good strength and casting qualities
E326	4.0		3.0						21	17	2.0	60	20	8,500	Tight castings — good strength
—	12.0								24	18	1.5	75	20	10,000	For pressure tightness without shock
43	1.2	1.2		1.5					22	14	2.0	70	20	8,500	General purpose castings
34	10.0	1.2			0.2			T2	25	21	1.0	75	25.5	9,500	"Piston alloy."
								T61	36	30	1.0	100	29.5	——	
39	4.0				1.5	2.0			28	24	1.0	85	24	8,000	"Y" alloy; for pistons
								T61	37	—	0.5	100	32	8,000	
E315	1.0							T4	31	16	8.0	65	27	6,000	Standard heat-treatable alloy
								T62	40	27	2.0	95	30	7,000	
								T6	36	22	4.0	80	29	6,000	
220					3.75				25	12	9.0	50	19	5,500	Resists tarnish; cooking utensils
					6.0				27	16	6.0	60	23.5	——	Slightly stronger than 214
324					10.0			T4	44	26	13.0	75	33.5	7,500	Strongest casting alloy
	2.0		4.0		0.3				26	20	1.8	65	18.5	——	For intricate castings
322	1.25		5.0		0.5			T4	30	20	4.0	60	30	——	For cylinder heads
								T6	35	27	2.0	80	30	——	
	4.4		5.0		0.5	0.75	0.75	T51	28	24	1.4	60	—	——	For water-cooled cylinder heads
								T59	25	21	1.9	55	—		
323			7.0		0.3			T4	28	16	6.0	55	22	——	For intricate shapes; avoids strains
								T6	32	22	4.0	70	23	8,000	
31	2.5	1.5		11.0					29	22	4.0	70	22.5	7,500	High strength, lowered corrosion resistance
Die Casting Alloys															
305			12.0						33		1.3	80			High salt water resistance; for thin-walled castings
312	8.0		3.0						32		1.3	70			Cheap general purpose alloy
	14.0		5.0						44		0.2	100			
—	2.0		3.0						30		3.5	60			
307	4.0		5.0						35		3.0	70			
309	4.0		2.0			4.0			32		1.0	80			For polished parts

(Continued on page 815)

In the interests of hundreds of engineers, designers, and production executives, to whom better coil and flat springs are of vital importance, Instrument Specialties Company is planning a comprehensive exhibit of "Micro-processed" beryllium copper springs and engineering data—to be shown at the National Metal Congress, Room 713, Palmer House, Chicago, from October 18th through the 22nd.

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Room 713, Palmer House, Chicago,
October 18th to the 22nd.

INSTRUMENT SPECIALTIES CO., INC.

DEPT. M-2, LITTLE FALLS, NEW JERSEY

Engineering File Facts

NUMBER 24 (Continued)

ALUMINUM ALLOYS

Alloy Number	Specifications: ASTM	Specifications: Army, Navy, Aero., AN-	Specifications: SAE	Composition, per cent: Cu	Fe	Si	Zn	Mg	Ni	Mn	Temper	Ult. Str., 1000 p.s.i.	Yld. Str., 1000 p.s.i.	Elong., % in 2 in.	Hard. Brinell	Shear Str., 1000 p.s.i.	Fatigue Str., p.s.i. 5×10^8 cycles	Uses
Wrought Alloys																		
2S	B25-42T	W-298 (2S)	25								O	13	4	35.0	23	9.6	5,000	Commercial wrought aluminum
											½H	17	14	7.0	32	11	7,000	
											H	24	21	5	44	13	8,500	
3S	B79-42T	T-13	29							1.25	O	16	5	30	28	11	6,000	Improved strength characteristics
											½H	21	18	6	40	14	9,000	
											H	29	25	4	55	16	10,000	
4S	—	—	—					1.0		1.25	O	26	10	20	45	16	14,000	Improved strength characteristics
											½H	35	31	5	65	19.5	15,000	
											H	42	38	3	80	23	16,000	
14S	—	A-8	—	4.4		0.8		0.35		0.75								Strongest for forgings
17S	B78-42T	QQ-W-298 (17S)	26	4.0				0.5		0.5	O	26	10	20	45	18	11,000	Most common strong alloy "dural"
											T	58	35	20	100	35	15,000	
											RT	61	46	13	110	36		
A17S	—	QQ-W-298 (A17S)	—	2.5				0.3			O	22	8	22	38	15	—	Dural-age at room temperature
											T	40	22	22	70	25	13,500	
B17S	—	—	—	3.5				0.3			O	22	8	22	38	15	—	Dural-age at room temperature
											T	48	25	20	80	29	15,000	
C17S	—	—	—	4.0		1.25		0.5		0.5	O	28	12	18	45	19	—	Dural - precipitation treatment required
											W	58	35	18	100	35	—	
											T	65	52	10	118	37	14,000	
18S	—	—	—	4.0				0.5	2.0									Strong at elev. temps. — forged pistons
24S	—	A-12	24	4.2				1.5		0.5	O	26	10	20	42	18	—	High strength possibilities
											T	65	43	20	105	40	14,000	
											RT	68	53	13	116	41	14,500	
25S	—	—	27	4.5		0.8				0.8	O	26	10	20	45	18	8,000	Good hot working characteristics
											W	48	25	18	80	30	14,500	
											T	58	35	20	100	35	15,000	
32S	—	—	—			12.0		1.0	0.8									Low expansion coeff. — forged pistons
51S	—	—	280			1.0		0.6			O	16	5.5	30	28	11	6,000	For forgings with thin sections
											W	35	20	24	64	23.5	16,500	
											T	48	38	14	95	30	10,500	
53S	—	—	—			0.7		1.25			O	16	7	25	26	11	7,000	High tarnish resistance
											W	29	18	22	65	22	—	
											T	35	30	12	80	26	11,000	
70S	—	—	—	1.0			10.0	0.4		0.7								Low cost forging alloy

These data were assembled from publications of the Aluminum Company of America, American Smelting and Refining Company, and General Motors Corporation

Compiled by Kenneth Rose, Engineering Editor

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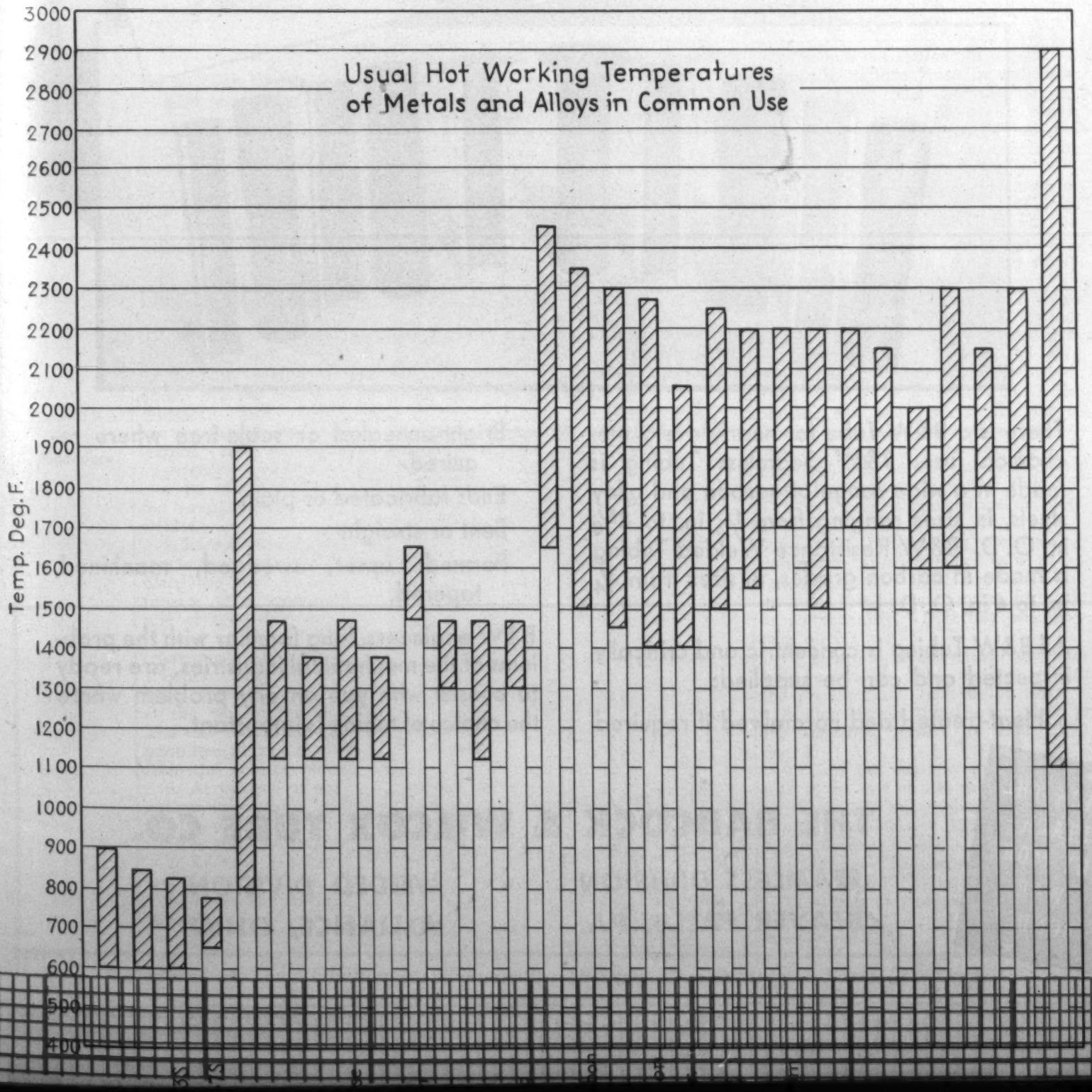
METALS and ALLOYS

Engineering File Facts

NUMBER 25

GENERAL ENGINEERING DATA

Hot Working Temperatures



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METALS and ALLOYS
Engineering File Facts

NUMBER 26

Tool-Tipping by Welding

Method	Resistance Flash Welding			Pressure Welding
Application	This method is particularly adapted to butt welding a high-speed tip to a simple steel shank, but may also be used for welding a tip to the face of a simple steel shank adjacent to the end, although considerable care is required in this procedure. It is desirable, for butt welds, that the areas of the sections of the two parts to be welded be as nearly equal as possible in order to avoid disproportionate rates of heating. A difference of 10 per cent is the maximum that should exist in applications of this method.			This method is suitable for jointing high-speed stubs to simple steel shanks. The minimum size that can be welded economically is about ½ inch.
Apparatus	A tempering furnace. A standard resistance flash welder, manually operated or motor or hydraulically driven, and equipped with changeable copper dies machined to fit the contours of the sections to be gripped during welding.			Manual, mechanical, or hydraulic pressure machine that can apply 4,000-4,500 lb. per sq. in. of pressure. Pressure gage capable of measuring twice this pressure. Alignment holding jigs. Heating apparatus, variable with size and shape of cross section to be welded, providing for oscillation of flame through a short distance of above and below weld section. Auxiliary furnace capable of attaining temperature of about 1650 deg. F. for slow-cooling welded piece.
Procedure	**For Welding Hardened High-speed Steel** 1. Preheat the parts to be welded to about 1000 deg. F. 2. Clamp the tip or stub in one pair of welding dies, and the shank in the other pair. 3. Make sure the alignment is correct. 4. Weld. The duration of the flash, the pressure, and the amount of upset required for an efficient resistance flash weld are details that can be learned only through experience. Assistance may be obtained from the manufacturer of the welder. 5. Immediately at the conclusion of the weld, place the tool in the furnace at a temperature of 1000-1050 deg. F. and maintain this temperature for about 2 hours. This will relieve thermal stresses at the welded section. The tool should not be permitted to cool in air from the welding heat. 6. At the end of the tempering period, remove the tool from the furnace and cool in air. 7. Remove and flash and dress the upset. 8. Form the cutting edge.	**For Welding Annealed High-speed Blanks to Simple Steel Shanks, Not For Subsequent Forging** 1-4 as above. 5. At the conclusion of the weld, bury the tool in lime, mica, ashes, or other inert material until cool, to prevent excessive thermal shock. 6. Anneal the tool according to high-speed steel practice. 7. Remove the flash and dress the upset. 8. Form the cutting edges. 9. Harden and temper according to high-speed practices.	**For Welding Annealed High-speed Blanks to Simple Steel Shanks for Subsequent Forging** 1-4 as above. 5. From the welding temperature, cool the tool in lime, ashes, or other inert material. 6. Anneal the tool according to high-speed steel practice. 7. Forge. Then cool in lime, ashes, etc. 8. Anneal according to high speed practice. 9. Form the cutting edges. 10. Harden and temper according to high-speed practices.	1. Smooth cut sections to be welded. A smooth machine finish or equivalent is satisfactory. The cut must be perpendicular to the length of the pieces. 2. Secure the high-speed stub and simple steel shank end to end in the welding apparatus. 3. Apply an initial end pressure of about 1,000 lbs. per sq. in. of joint cross section. 4. Ignite the gas in the heating head. Adjust the flame to a neutral or slightly reducing ration. 5. Oscillate the heating head across the weld interface through a distance of about one-third the weld face diameter in either direction from the weld face, allowing a slightly longer play of flame on the high-speed side. The pressure will now rise rapidly, due to thermal expansion of the heated sections. Then, as the metal in this weld zone becomes heated into the plastic range the pressure gradually falls off. This will be at a temperature of 2300-2500 deg. F. 6. When the welding pressure has dropped to a predetermined value of between 3,000 and 4,000 lbs. per sq. in., maintain the pressure, either manually or automatically. Upsetting will now take place. 7. When a predetermined optimum weld upset has been reached, release the pressure, and remove the piece. 8. Immediately transfer the piece to the annealing furnace at about 1650 deg. F. 9. Cool the piece to room temperature at the rate of 100 deg. F. an hour or slower. If this cooling cycle is followed, a hardness of 325 B. H. N. or less will result. 10. Remove the excess weld metal. 11. Machine the cutting edges. 12. Treat the tool according to standard high-speed practice for the grade.

Prepared by Tools Division and Conservation Division, War Production Board, Washington

SHEET AND STRIP ROLLING MILL IN THE WORLD AT BALTIMORE

BALTIMORE, October 1st — Revere Copper and Brass Incorporated announces its entrance into magnesium production. It will soon begin operating the largest magnesium sheet and strip rolling mill in the world.

It is indeed significant that Revere—the oldest name in the entire non-ferrous industry—now becomes associated on a large, important scale with the newest metallic material whose almost magical lightness and versatility predestine it to an epoch-making future.

It may be well said that the pioneering spirit of Paul Revere himself still carries on with all its trail-blazing fame.

The Company is planning a limited production for the immediate future, but will increase the quotas until the mill reaches its capacity in January, 1944.

Three Important Alloys Offered

Revere will make three most commonly-used sheet magnesium alloys.

Revere Magnesium "M" will be a magnesium-manganese alloy, possessing moderate strength with good forming characteristics.

Revere Magnesium "J-1" will also be offered. This is the highest strength sheet on the market, used principally by the airplane industry. This is a magnesium-aluminum-zinc alloy.

In addition, *Revere Magnesium "FS-1"*, a magnesium-aluminum-zinc alloy will be produced. This alloy will possess higher physical characteristics than "M", but lower than "J-1" and, combining with these improved strengths, it will also possess a good forming quality.

As a large producer of magnesium sheet and strip, and in view of the expanding usefulness and applicability of this wondrously light metal, Revere will now be able to serve American industry in many fields, from aviation to railroads.

Some typical uses in addition to transportation: various small mechanical parts; reciprocating elements in textile machinery; works of calculating machines; housing for portable machinery; typewriter frameworks—the possibilities are almost endless it would seem. As developments ensue, Revere will be ready to supply requirements and offer appropriate technical advice.

The new Research and Development Department of the Magnesium-Aluminum Division at Baltimore will be of material aid in working with Revere customers in the solution of any of their particular manufacturing problems.

Manufacturers who would know more of the possible adaptability of the various Revere magnesium alloys to their needs, are invited to write us, *without obligation*. Address all inquiries to:
Revere Copper and Brass Incorporated,
Magnesium-Aluminum Division,
P. O. Box 2075, 1301 Wicomico Street,
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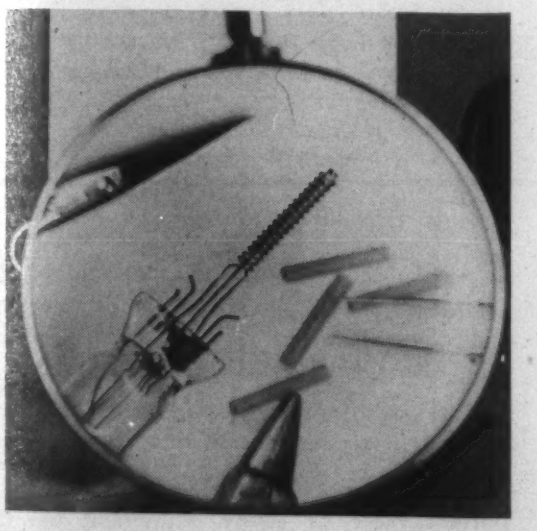
Spaghetti Used as Welding Jig

by William A. Hayes,
Westinghouse Lamp Div.

Spaghetti was substituted for a piece of steel in making electronic tubes at the Westinghouse Lamp Div., an idea that might find applications elsewhere. It cuts by 75 per cent the time required to assemble certain tube filaments and reduces the need for critical steel.

A stick of spaghetti placed inside a tiny wire coil supports the coil while it is being welded. A piece of steel was formerly used as the support, but it was difficult to remove. Spaghetti can be burned out in a flash.



Wire filaments for many tubes are coiled in the shape of a small spring, ¾ in. long. When a coil was welded to the rest of the tube mechanism, a steel piece, thick as a 7-penny nail, was inserted inside the spring coil to support and keep it in alignment. The steel had to be split with a saw before inserting in the coil; otherwise it would be hard to remove later because the coil tightened around it. Removing it often jarred the coil and it had to be realigned.

With the spaghetti, electric current is passed through the coil to remove impurities in the metal, at the same time burning up the spaghetti in a flash.

The Italian food staple used to be turned in a lathe to precise diameter. Now the spaghetti is made in a special die to correct size. The method was first applied to only one type of tube, but its use will be appropriate for others in the future.

Cemented Carbide vs. Steel File Scrapers

by H. Crump,
Carboloy Co., Inc.

Commercial scrapers tipped with cemented carbide are taking the place of files in the tool rooms of machine shops. One of the bottlenecks in machine tool production was the necessity for carefully hand-scraping the ways and slides to a high degree of finish and accuracy.

Steel scrapers — mostly converted files — proved too slow: a few scrapes, and they had to be sharpened again. Flame hardening further decreased the life per grind of the steel scraper. Some steel surfaces with weld spots could not be scraped at all.

Tests carried out at Battelle Memorial Institute revealed that by tipping scrapers with Carboloy cemented carbide, the formerly unscrapeable surfaces could be scraped with a longer life per grind. Thus, on flame-treated

cast iron, Rockwell "C" 40, 25½ sq. in. could be finished per grind with a carbide scraper as against none for the converted carbon steel file.

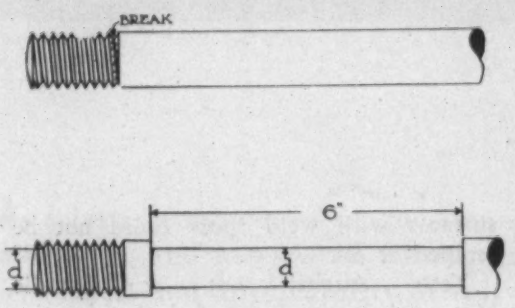
The average for all materials scrapeable with both types showed approximately 6½ sq. in. finished with carbon steel as against 75 sq. in. for the carbide-tipped scraper. Neither did the carbide scraper scratch or dig into the surface, a common trouble with the other kind.

In the accompanying photo one of the new cemented carbide-tipped scrapers is being used.

Bolt Diameters and Strength

by W. F. Schaphorst

A customer entered a shop with two broken bolts that had ruptured at the termination of the thread, as indicated in the upper diagram. The bolts had broken there twice before. The shop man explained that the stress was ob-



viously too high at the root of the thread, the point of common breakage. The stress being greatest there, the stretch must also be greatest at that spot.

He placed undamaged bolts in a lathe and turned them down to a diameter equal to that at the foot of the thread, thus distributing the stretch over the entire 6-in. length of the bolt, as shown in the lower diagram. No more trouble was experienced by the customer.

It has long been known that a bolt or rod is less likely to break if its diameter is about equal to or less than the diameter at the root of the threads.

To separate heat-treated parts from those not heat-treated but of identical appearance, a magnetic discriminator has been developed. It works on the principle that heat treating increases the permeability, and thus gives a stronger magnetic field. A system of balanced magnetic fields used with an oscilloscope provides easy visual determination of the difference.

—"Ohmite News,
Ohmite Mfg. Co.

Heat Treating High Speed Steel

by Michael V. Chiovare,
Forge Plant, Dodge Div., Chrysler Corp.

To avoid the warpage and distortion sometimes occurring in heating high-speed steels, a double pre-heat, first at 1000 deg. F., then at 1525 deg. F., is advised. The steel should be soaked at the higher temperature, then quickly transferred to a temperature of 2225 deg. F. Furnaces with controlled atmosphere are preferred. If done in a furnace without atmosphere control, the metal surfaces should be coated with borax.

An interrupted quench is suggested when a hot quenching medium is not at hand. The piece should be cooled to about 300 deg. F., then placed in a draw furnace at 1025 deg. to 1075 deg. F. An air blast quench has been found satisfactory also, segregation cracks being minimized and hardness of Rockwell C-64 to 65 obtained.

Double-drawing of high-speed steel, to eliminate austenite, is recommended if tools show low hardness readings with usual methods of handling.

Grinding wheels can be chipped, cracked or broken by careless handling. While rubber and resinoid bonded wheels usually can stand more abuse than vitrified and silicate wheels, all wheels are "breakable," and in order to be on the safe side, handle all wheels as carefully as you would your best dinner plates.

—"Grits and Grinds,"
Norton Co.

Counterweights vs. Hand Spotfacing

by John D. White,
Cadillac Motor Car Div.

In a spotface operation it was necessary to hold down the hand-feed lever on the drill press. It occurred to us that

by using a weight on the lever it would automatically accomplish the operation faster, more satisfactorily and enable the operator to work another spindle of the machine at the same time.

Production was increased, and the finish was improved, due to the fact that weight can be shifted on the lever to

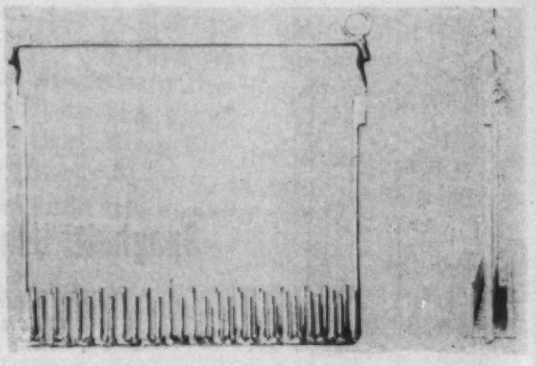
produce the pressure necessary for the finish desired.

The accompanying two photographs show "before" and "after" use.

Steel Plating Rack Saves Copper

by Alfred A. Wald

A chrome plating rack was made by welding 1020 SAE steel to copper hooks with copper electrodes, the purpose being to use as little copper, a critical metal, as possible. It was necessary that the hooks themselves be of electrolytic



copper as they rest on the work bars in the plating tanks and must make perfect electrical contact.

The racks carry a heavy machine part that fits these pins in the rack, and the pins must be held very close as the clearance tolerance is practically nil.

[This idea won an award for the author in an arc welding contest conducted by Hobart Brothers Co., Troy, Ohio. —The Editors.]

A steel ball bearing and an ordinary steam boiler glass can be used to make fairly accurate hardness measurements. The material to be tested is placed on the table and one end of the glass tube placed and held vertically on the material. The ball is dropped through the tube. The higher the ball bounces when it is dropped, the harder the material.

—"Oxy-Acetylene Tips,"
Linde Air Products Co.

Aluminum Melting Furnace

by H. J. Hunt,
General Electric Co.

More than 2500 castings for an important piece of Army equipment have been made with a 1000-lb. capacity portable melting furnace and ladle combination at General Electric's Schenectady Works, with negligible rejects. One third of the castings were of an aluminum alloy, 5 per cent silicon; the rest of an aluminum-copper-silicon alloy.

The portable furnace obviates the need of super-heating its charge to where oxidation would be excessive; it allows a direct pour from furnace to mold; it does away with preheating transfer ladles and molds.

It is a conversion of a standard oil-fired furnace and ladle, is trunnion-mounted, with two eye plates on both frame uprights for lifting. Best pouring temperature is 1292 to 1310 deg. F. Ordinarily the aluminum charge would be heated to 1472 deg. F., but with this combination, only 1382 deg. F. is necessary. The furnace needed only two relinings for the 2500 charges. Total weight, loaded, is 3 tons.

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Alumina from Low Grade Domestic Ores

Condensed from "Mining and Metallurgy"

[*In a recent issue of Mining & Metallurgy, R. S. Dean, assistant director of the Bureau of Mines, presented under the general title "Production of Alumina from Low-Grade Domestic Materials" a review of the work of the Bureau in that field. His article was supplemented in the same issue with another by P. D. Wilson, of WPB's Aluminum and Magnesium Division, covering the work done by other agencies than the Bureau. Both articles are abstracted here.*—The Editors]

The Bayer process of producing alumina dates back to a patent issued in Germany in 1888 to Karl Josef Bayer. Though modified and improved, it has remained the universally used process for making aluminum hydrate, which, when calcined, yields the oxide used in the Hall-Heroult process for producing aluminum from alumina.

In the Bayer process the iron oxide content of the bauxite is insoluble in caustic soda and, aside from increasing the bulk of the insoluble residue which must be filtered and thrown away, presents no problem. However, the silica presents an entirely different picture, as it is the cause of serious losses of both soda and alumina, which increases with increasing silica content. For every pound of silica, 1.1 to 2 lb. of alumina and 1 to 3 lb. of soda are lost.

The ore for the Bayer process has until recently carried only as high as 7 per cent silica, but slightly higher silica content is now being tolerated. The higher the silica content, the more expensive the alumina, but the purity of the alumina is not affected.

The present definition of bauxite is "A mineral raw material which is used as the ore of aluminum, consisting mainly of hydrated aluminum oxides." American bauxite's essential mineral is gibbsite, the trihydrate of alumina. Diaspore, the monohydrate, is much less plentiful.

The Bureau's Work

The lime-soda-sinter process is being adapted by the Bureau of Mines to handle high silica bauxites (up to 25 per cent). This consists of (1) Calcination of the bauxite with admixtures of limestone and soda ash; (2) Leaching of the sintered bauxite for extraction of the soluble alumina; (3) Pressure treatment of the sodium aluminate solution for partial removal of silica; and (4) Precipitation of the alumina of the desired physical and chemical properties. Plants combining the Bayer with the lime-soda-sintering process are being designed and constructed which will use bauxite averaging between 13 and 15 per cent silica.

Beneficiation of high silica bauxite provides use of the mineral up to 15 per cent silica. With many ores iron and titanium can be removed by magnetic separation or gravity concentration, but these methods are ineffective for rejection of silica. Flotation or a combination of flotation and gravity concentration must be used, all procedures developed by the Bureau of Mines.

The ammonium-sulphate-exchange process has been studied by the Bureau and interested industrial concerns. All steps involved are common to the chemical engineering industries. It is currently being considered for application to clays.

A mixture of pulverized clay and ammonium sulphate react at 710 to 750 deg. F. in a rotary kiln, forming ammonium aluminum sulphate (alum) with the evolution of ammonia, or ammonium carbonate. The reacted mass is then leached at 200-212 deg. F. with water and a small portion of sulphuric acid. The hot solution is crystallized in two stages and the alum crystals are further treated.

Work Done by Other Agencies

Mr. Wilson commented on Dr. Dean's article (abstracted above).

As to the lime-soda-sinter process it is surprising that Dr. Dean says that this process is "being adapted by the Bureau." He implies that all of this work is based on the Bureau's investigations. The Aluminum Co. of America worked for several years on this particular process and developed it to the point where the Aluminum and Magnesium Div., WPB, authorized the construction of lime-soda-sin-

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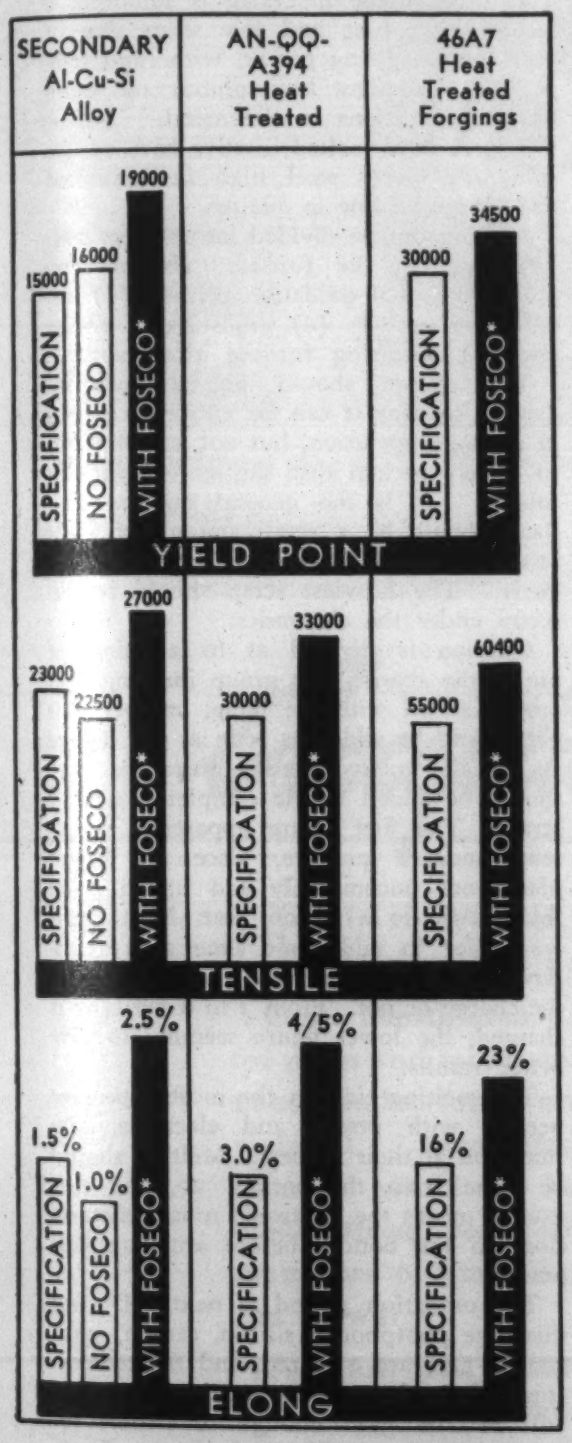

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ter units at the cost of many millions—and for treating economically and efficiently domestic bauxites averaging 13 to 15 per cent silica. The indications are that an adaptation of the process can be applied well to high-aluminous clay.

Dr. Dean neglects to mention another important alkaline process for the production of alumina from clay: The lime-soda-sinter leach method developed by the American Nepheline Corp., a process approved by the National Academy of Science committee and adopted by W.P.B. for a semi-commercial plant to be erected in South Carolina to use local high-aluminous clay.

In discussing the Bayer process Dr. Dean says that for every pound of silica 1.1 to 2 lb. of alumina and 1 to 3 lb. of soda are lost. Good practice envisages the loss of the smaller amount in each case but it would be extremely poor practice which would cause loss of 2 lb. of alumina or 3 lb. of soda.

He mentions diaspore as a monohydrate of alumina. Actually the monohydrate found in certain bauxites is not diaspore but boehmite, a major constituent of many European bauxites. Boehmite is soluble in Bayer solution of the caustic concentration but diaspore is insoluble.

It is strange that Dr. Dean's paper should have failed to mention the contributions of the War Production Board, of the National Academy of Sciences Committee and of the many companies that have carried through to completion pilot plant work on many processes, Mr. Wilson concludes.

—R. S. Dean, *Mining & Metallurgy*, Vol. 24, Aug. 1943, pp. 356-359; P. D. Wilson, *Ibid*, pp. 359-361.

Wartime Engineering Steels from the Electric Furnace

Condensed from "Blast Furnace and Steel Plant"

The basic electric furnace has certain definite advantages over other steel producing units. They are: (A) Steel can be produced rapidly under non-oxidizing equilibrium conditions; (B) cleaner, more uniform steels can be made commercially with higher yields and lower rejections; (C) poorer raw materials can be converted into higher quality products; (D) closer analysis limits can be maintained.

These major advantages result in other advantages of considerable importance. It is possible to recover valuable oxidized elements, such as chromium, manganese, vanadium and tungsten, with much less loss than in even the best open hearth practice. Control of grain size and hardenability are simpler, greater homogeneity is possible, most ladle additions can be avoided, and higher temperatures can be better controlled.

In production it compares favorably with the best basic open hearths, with the average figure about 9 tons per hour. It is ideally fitted for duty as a refining medium, and most economical results can be obtained by combining it with the least expensive method of converting solid scrap to liquid metal, the cupola.

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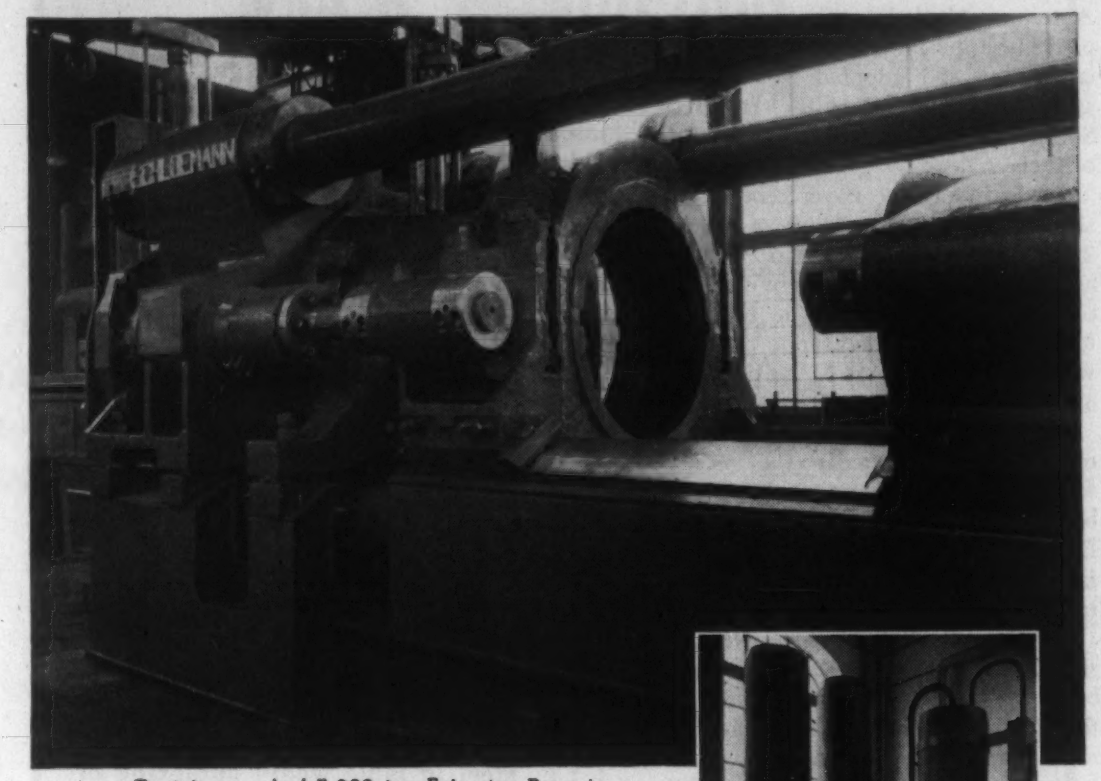

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Electric Furnace Practice

Melting of steel in the basic electric furnace has three fundamentals:

(1) When the charge is melted, the combination of a high degree of oxidation plus high lime in the slag and low temperature permits elimination of phosphorus as calcium phosphate.

(2) After the first slag is removed, a second high lime and low silica slag of very low oxidizing power, with high temperature, promotes low sulphur and equilibrium conditions in the metal.

(3) A dead melted inactive bath on the cold side means steel high in inclusions and otherwise low in quality.

Melting can be divided into six periods: (a) charging the furnace; (b) melting the charge; (c) oxidation period; (d) deoxidation period; (e) adjusting of analysis; (f) repairing furnace after tapping.

The charge should be of sufficient density so that it can be entirely charged in a single operation, but not so solid nor so closely packed that the arc will be localized. It is the general opinion that there should be a small amount of light scrap on the bottom inside the electrode circle. The heaviest scrap should be directly under the electrodes.

Opinion is divided as to addition of ore to the charge, one group insisting that ore be added with the scrap, another that ore should be added as soon as the charge is partially melted, and a third that ore should be added to the completely melted scrap. The first group apparently represents modern practice, since the larger plants not uncommonly add up to 3000 lbs. of ore to a 60-ton heat. Most melters prefer to add some lime after meltdown, whether they have added any with the charge or not. From 2 to 4 per cent is charged, the lower figure seeming to give better results.

The melting time is the most expensive period, with power and electrode consumption at their highest. Melting should be done from the bottom up, and this usually means the electrodes must penetrate close to the bottom before applying full power.

The oxidation period is next. During this time phosphorus, silicon, carbon, manganese, etc., are oxidized, and the temperature of the bath is increased so the steel will become fluid enough to permit removal of non-metallic inclusions. Steels which must be low in hydrogen, and lower carbon steels, require more oxidation than high carbon grades. Lower phosphorus is also insured. The bath should be checked for analysis as soon as it is completely melted down.

At the end of the oxidation period the steel should be increasing rapidly in temperature, approaching at least 2900 deg. F.; carbon should be about 10 points below the desired minimum; silicon close to zero, and residual manganese about .20 per cent. Insoluble oxides must be removed and others reduced to metallic

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form. A manganese or spiegel reboil may accomplish this. Manganese silicates and oxide pass into the slag and are removed at slag-off. Temperature at this time should be above 2900 deg. F. to promote removal of nonmetallics.

After slag-off, manganese is introduced, followed by a strong deoxidizing agent, as aluminum, or one of the silicon-aluminum-calcium combinations. Iron oxide is lowered to bring the bath into equilibrium with the new low-oxide slag.

Alloy Additions and Finishing

There is no reason why all of the major alloy additions should not be made at this time. After their adding, high power may be applied to the bare bath to overcome the chilling by the alloys, and the second slag added next. This is a mixture of lime, spar and coke, and in some cases silica sand. Two per cent of the charge weight is usually a satisfactory amount. In some plants a cement clinker is added after alloy additions, or even before adding chromium.

The second slag should begin to shape up in 15 to 20 minutes, and by the time the laboratory report is back, should be in shape to add the ferro-silicon. If the bath is not completely deoxidized, there will be a tendency to form excessive silicate inclusions, so the addition should not be made until the slag shows on test an iron oxide content of approximately ½ of 1 per cent.

With the return of the analysis test, the carbon and manganese additions to meet specifications are made, and then aluminum for grain size control, if necessary. During this time the power is increased to provide a tapping temperature of about 3000 deg. F. on medium and low carbon steels.

The time from slag-off to tap varies considerably, but the shorter the better. In one successful plant the time with 60-ton furnaces is not over 75 minutes.

—H. W. McQuaid, *Blast Furnace & Steel Plant*, Vol. 31, June 1943, pp. 641-644; July 1943, pp. 776-779.

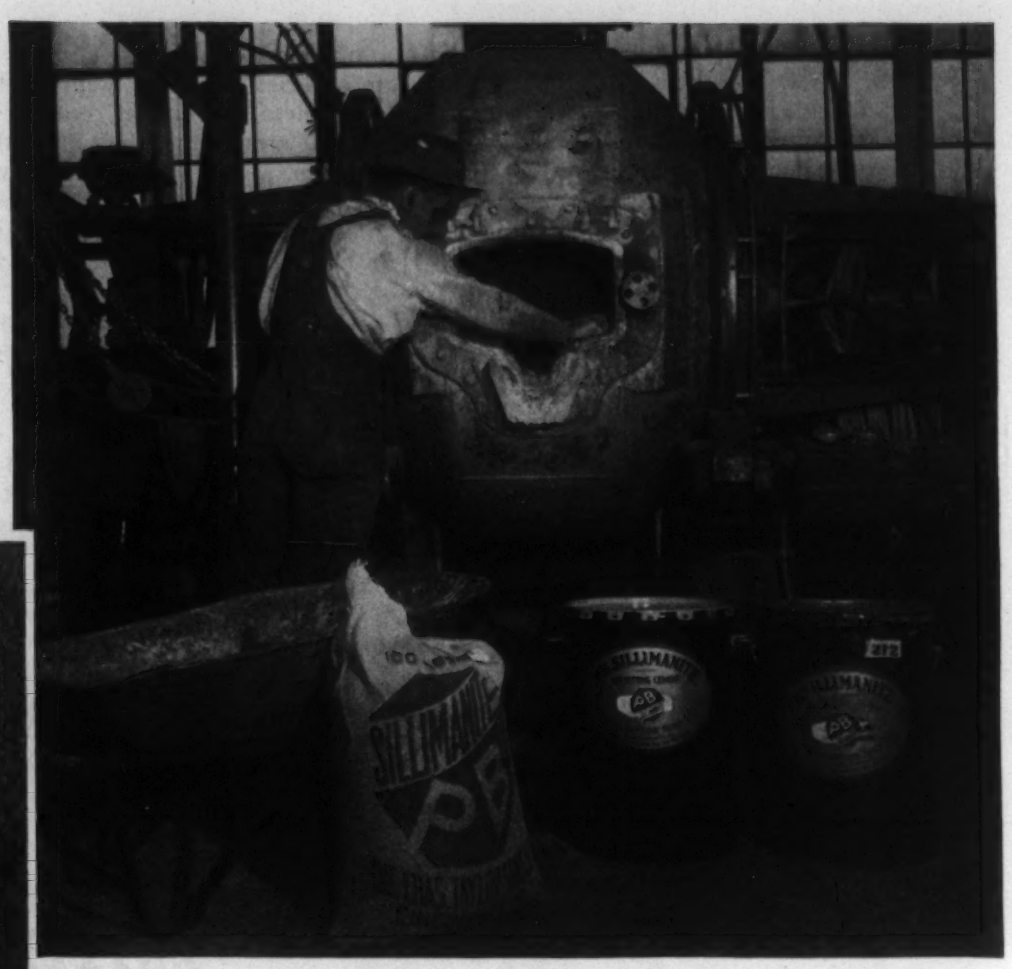
Inclusions in Steel from Casting Pit Refractories

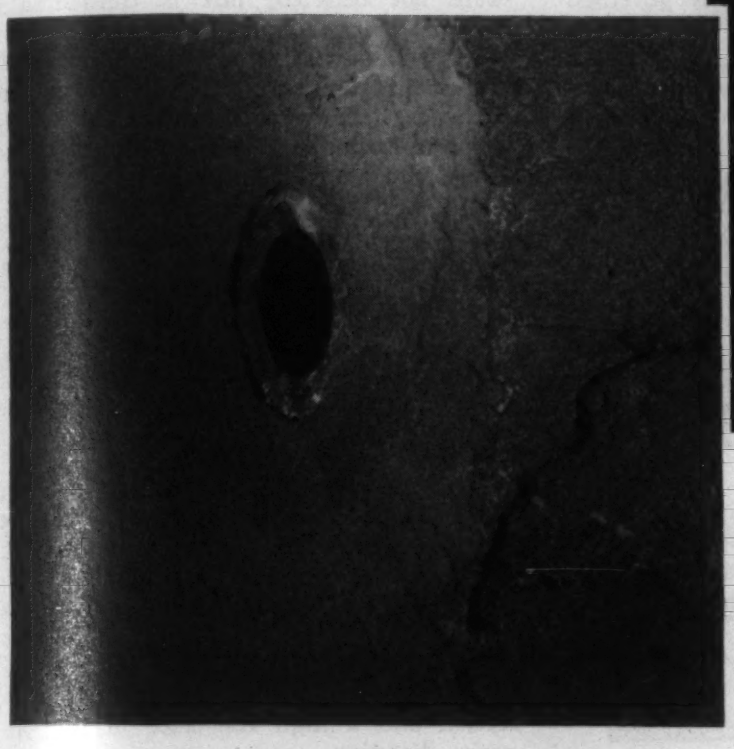
Condensed from Transactions of the British Ceramic Society

The failure of a high percentage of forgings to meet transverse elongation requirements was thought to be due to an increase in the non-metallic inclusions of the slaggy stringer type. As this coincided with the use of more siliceous refractories for the uphill casting, a systematic investigation of casting-pit refractories as a source of these inclusions was made. The following conclusions were reached:

(1) The manganese of the liquid steel reduces the free silica, particularly the quartz of the refractory, to produce MnO and silicon in tending toward equilibrium, since the manganese-silicon ratio of the steel is greater than the equilibrium value. The MnO thus formed fluxes the refractory to form a liquid manganese aluminosilicate slag. The amount formed on the siliceous refractories is very much greater

DETROIT ELECTRIC FURNACES





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than on the aluminous refractories (38 per cent Al_2O_3).

(2) The slag is washed off the runner bricks and carried into the ingots, where, in the case of the small 11-in. ingots, freezing is sufficiently rapid to trap some of it.

(3) During forgings these manganese alumino-silicates are plastic and are deformed into stringers.

(4) Composition and amounts of slag formed on a given type of refractory by different alloy steels with similar carbon, manganese and silicon contents are very similar. Alloying constituents have little influence.

(5) Compositions of the manganese alumino-silicate slags formed on uphill refractories by steels with similar carbon, manganese and silicon contents fall within a small area in the MnO-SiO_2-Al_2O_3 ternary diagram. The line from MnO through the composition of the slag intersects the Al_2O_3-SiO_2 side at the approximate composition of the firebrick from which it is derived.

(6) Composition of the slaggy inclusions is therefore controlled by these elements in the steel and composition of the refractories.

(7) Crystallization paths of these slags can be obtained from the MnO-SiO_2-Al_2O_3 diagram recently published by R. B. Snow. Completion of crystallization is governed by subsequent heat treatment of the ingots.

(8) These inclusions are derived from uphill refractories and tundish linings, and probably from any firebrick material with which the steel comes in contact.

(9) The silicates also occur on ingot surfaces.

(10) Constitution and properties of the refractories are extremely important. Manganese attack is greatly reduced when quartz is absent. Fireclay refractories should be fired at 1100 deg. C. (2000 deg. F.) minimum to obtain minimum free silica content. Maximum spalling resistance should occur at the same temperature or higher.

(11) Although inclusions due to spalling were not detected, this is considered a possible source of trouble.

(12) It has been found in various steelworks that boiling fireclay nozzles in tar increases their wear resistance. Probably the free carbon in the pores decreases the manganese reduction of silica.

—J. R. Rait, Transactions of British Ceramic Society, 1943, Vol. 42, pp. 57-90. In July, 1943 *Bulletin of the Iron & Steel Institute*, London.

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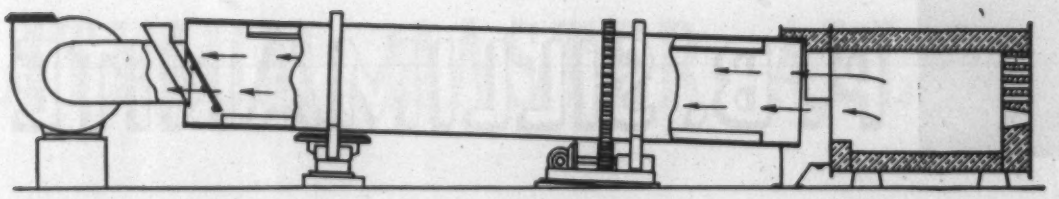

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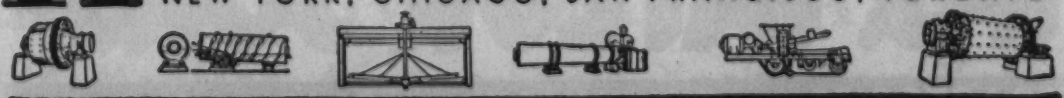

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Rectifiers for Steel Mills

Condensed from "Iron & Steel Engineer"

Although mercury arc rectifiers are not new in general engineering, they were not introduced in steel mill practice until 1937, when Republic installed a 1000-kw., 250-v. rectifier in their wire mill at South Chicago. A rectifier is like an electric check valve, since it presents a low resistance to the passage of current in one direction and a high resistance in the opposite direction.

Rectifier Construction

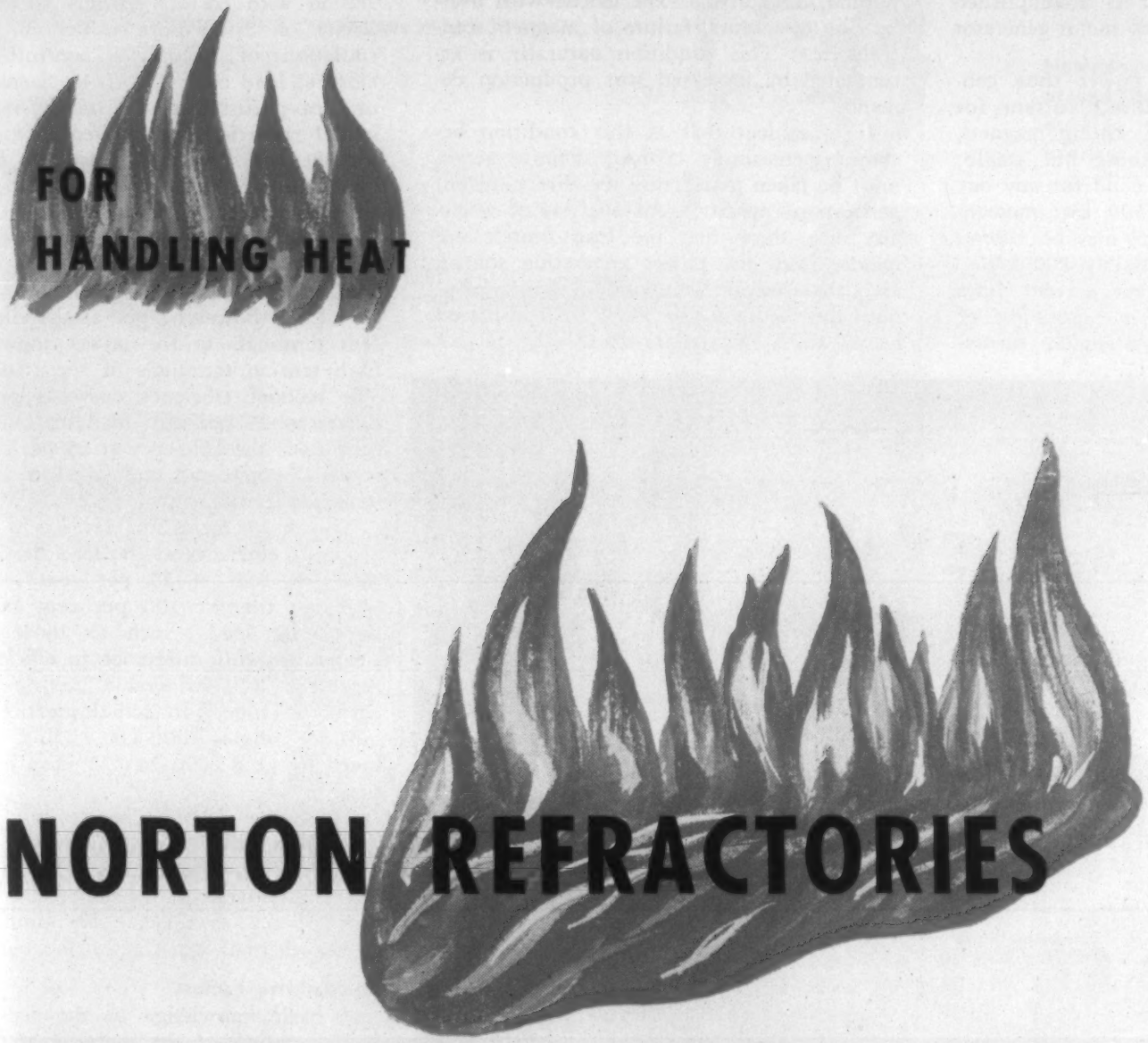
There are two types of mercury arc rectifiers: (1) the conventional metal-tank unit, consisting of a steel sheet vacuum-tight welded tank, with an insulated pan at the bottom for the mercury pool cathode and 6 or more graphite anodes connected through vacuum-tight insulated bushings to anode terminals at the top of the tank; and (2) the recently developed multi-tank rectifier, each tank containing its individual mercury pool cathode and a single graphite anode, one tank placed in each phase with all cathodes connected together to form the positive terminal of the rectifier. The second type is known as either the ignitron or the excitron.

The main difference between the two types is that each anode in the multi-tank rectifier is not exposed to the highly ionized mercury vapor of the main arc current during its non-firing inverse voltage period as in a multi-anode tank, and, therefore, the anode can be located closer to the mercury pool cathode of its individual tank.

This results in a much lower arc drop loss and a consequent improvement in efficiency, as the drop loss is constant regardless of output voltage. This is an important factor in the 250-v. operation used generally in the steel industry.

Service Conditions in the Steel Mill

Basically, the power system of the average steel mill consists of generation by the



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use of blast furnace gas, alternating current distribution at either 25 or 60 cycle to centralized substations where the conversion to direct current is accomplished by the use of synchronous motor-generator sets.

A large part of all power thus generated is converted to direct current for use by auxiliaries, cranes, lifting magnets, etc. This load is anything but stable; for instance, the peak demand for any one department may reach 1500 kw. momentarily, wherein the average may be around 600 kw. with dips to possibly 200 kw.

In addition, most direct current lines are quite long, due to the grouping of motor-generator sets at attended substations. This necessitates abnormally heavy distribution cables to reduce line drop losses; where this line drop loss is abnormal, difficulty is experienced with overheating of motors, failure of magnetic control, etc. This condition naturally is accentuated by increased war production demands.

It is evident that as this condition becomes increasingly critical, definite action must be taken to increase the direct current generation capacity. An analysis of a system may show that the load centers are remote from the power generation source, and that certain economics of distribution and maintenance must be considered before any additions are made.

In this case, a decision must be made between the installation of the new conversion capacity at the central attended substation with correspondingly increased capacity of distribution cables, or the installation of automatic controlled units close to load centers with its decreased use of heavy distribution cables. Shall we install the tried and proven motor-generator set with which we are all familiar? Or shall we consider the installation of the new mercury arc rectifier? Herein lies the problem of operating reliability, efficiency and maintenance.

The efficiency of the rectifier is the ratio of the power output at the direct current terminals to the power input at the high tension terminals of the transformer. The rectifier efficiency curve is practically flat from 25 per cent load up to 125 per cent load; the efficiency at 25 per cent load is 91.2 per cent, and at 100 per cent 91.8 per cent.

The motor generator set has a decided drooping efficiency as the load drops, being 79.2 per cent at 25 per cent load, and 88.7 per cent at 100 per cent load. In fluctuating loads, such as those met in steel mills, this difference in efficiency can represent a considerable saving over a period of time. In actual practice in one mill, a single 1000-kw., 250-v. rectifier saved about $3,000 in 521 days of operation.

Thus, the rectifier has a high overall conversion efficiency practically constant over the entire load range. It has a high momentary-overload capacity, the magnitude of the overload being limited only by the thermal capacity of the equipment.

Comparative Factors

A basic knowledge of the construction and operation of the mercury arc rectifier will remove the psychological obstacle to its use. The comparison of efficiencies shows a very decided advantage in favor of the mercury arc rectifier.

In operation and maintenance, the rectifier has the advantage in simplicity, smooth operation and cleanliness. In the effect on the a.c. power system, the use of capacitors for power factor correction places the advantage on the side of the rectifier, as it will not contribute power to fault conditions, and it does not impose abnormal demands in starting.

The first cost of the rectifier is somewhat higher than a motor-generator set, but the installation costs will be less as the foundations and structure can be lighter due to absence of vibration.

A balance of these factors shows the advantage to be on the side of the rectifier.

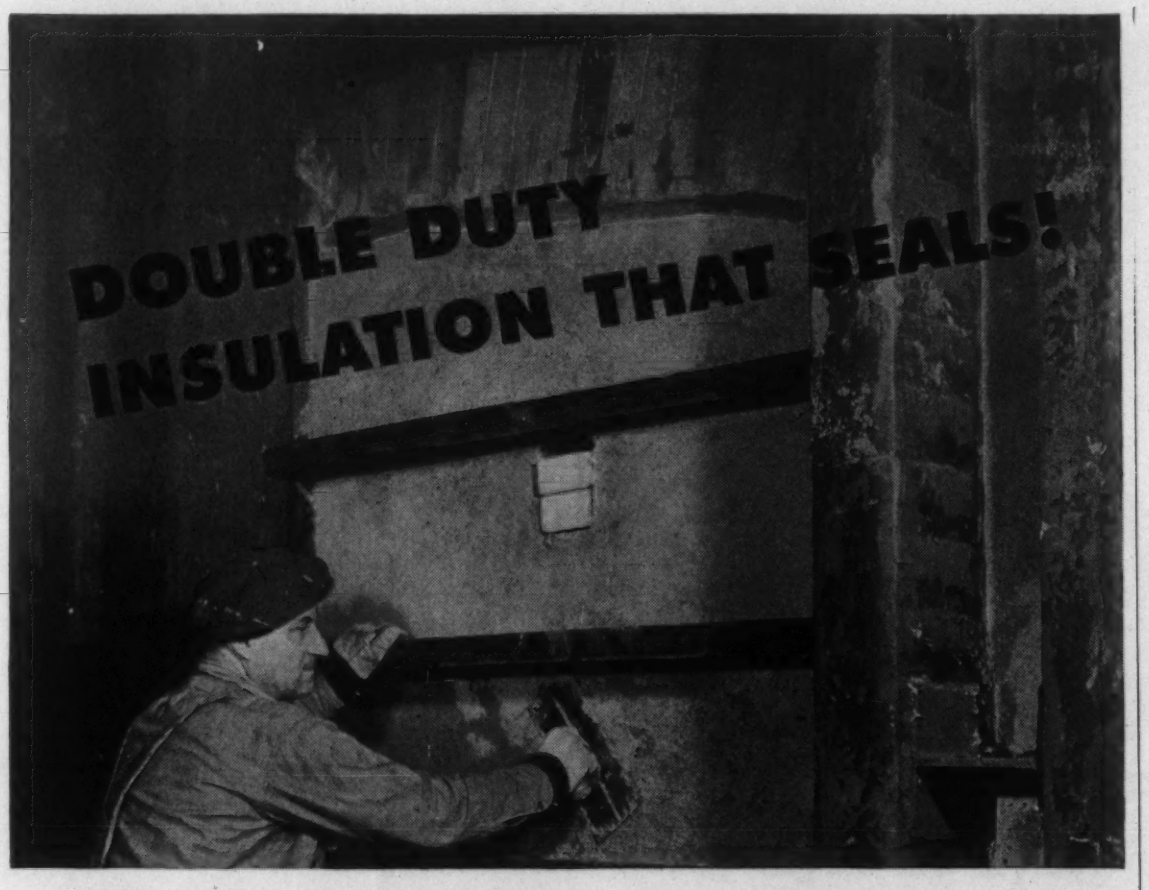
—A. D. Howry. *Iron & Steel Engr.*, Vol. 20, Aug. 1943, pp. 64-69.

Magnesium Melting and Casting

Condensed from "Foundry Trade Journal"

This is a prize winning entry for a Short-Paper competition organized by the London branch of the Institute of British Foundrymen for new members.

Magnesium is produced from magnesite and kindred material, which is found in most parts of the world, but principally in central Europe, Russia and on the con-



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tinent of America. It is reduced to metallic form by various well-known processes. The metal can be used for sand casting or die casting. Magnesium alloys can also be used for forgings and extrusion work.

Molten magnesium has an affinity for oxygen and an unprotected molten surface quickly burns. To protect the surface, a liberal use has to be made of suitable fluxes. All these fluxes contain substantially the same basic compound, such as anhydrous magnesium chloride, magnesium fluoride, potassium chloride, etc.

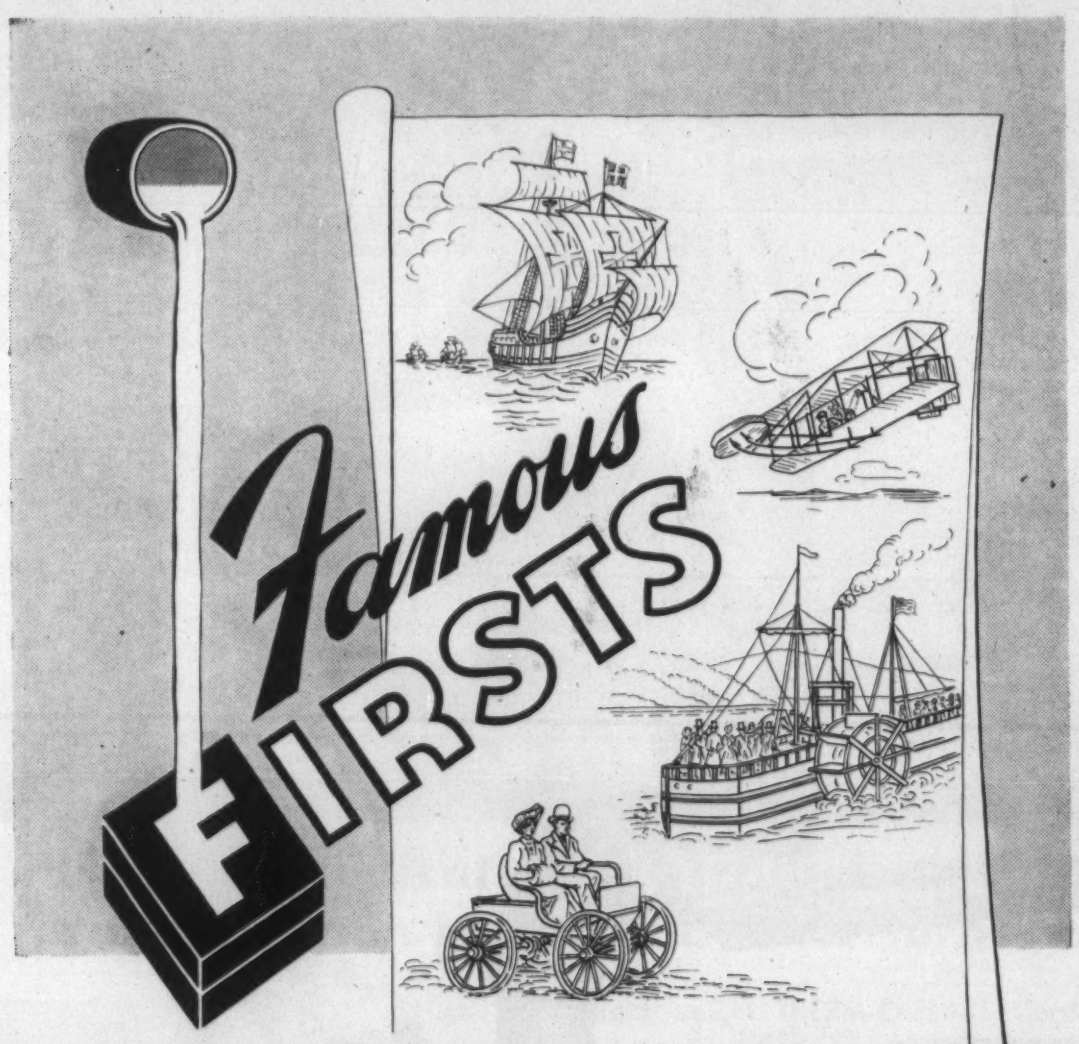
Flux to a total 5 per cent is added to the melt at a very early stage, and thereafter continuously to maintain a cover. It will be observed that the greater part of the flux disappears from the surface as it absorbs the oxide and other impurities, and sinks to the bottom of the pot. This is known as the washing action of the flux.

In the case of magnesium, the surface must not be left unprotected any length of time, and a crusting must be provided by a second application of flux. This is necessary, as at this point it is a general practice to superheat the metal to a temperature of 800 to 900 deg. C. (1470 to 1650 deg. F.) and then allow it to cool rapidly. The effect of this rapid cooling is to reduce the grain size and so increase the physical properties of the casting.

The metal is generally cast somewhere around 750 deg. C. (1380 deg. F.). Great care should be taken to skim thoroughly and see that no flux from the pot enters the mold. Moisture of the sand mold must be reduced to a minimum (*i.e.* a maximum 5 per cent), and an inhibitor must be introduced either into the sand or into the completed mold. Such inhibitors are commonly mixtures of boric acid and sulphur or ammonium bi-fluoride.

Mild steel pots are used for melting magnesium, as there is a tendency for magnesium to react with silicon in the plumbago crucibles. Gray iron pots are not used, since it is found that they also do not stand up to requirements sufficiently well.

—J. P. P. Jones, *Foundry Trade J.*, Vol. 70, June 3, 1943, pp. 94-95.



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Basic Open-Hearth Refractories and Maintenance

Condensed from "Industrial Heating"

Refractories used in the basic open-hearth furnace, and furnace maintenance, were discussed at a session of the Twenty-Sixth Conference of the National Open-Hearth Steel Committee and the Blast Furnace and Raw Materials Committee of the American Institute of Mining and Metallurgical Engineers, at Cleveland, April 29 and 30 of this year. Discussions were under four general headings: (1) maintenance of open-hearth bottoms; (2) basic roofs; (3) furnace maintenance; and (4) hot-topping steel.

Members reported success with the use of Ramix, a cold-ramming high magnesia refractory, as bottom material. One user reported 1200 heats in a 200-ton furnace, and considerable time saved in installation. Another reported successful patching with this material with only 12 hours downtime as compared with three days usually.

Basic roofs, it was stated, fail in the same manner as basic walls; that is, iron oxide builds up in the hot-face, and spalling occurs. The American practice of pushing furnaces causes conditions too severe for the basic roof, of burned or unburned brick.

A plant using a suspended Detrick-type roof over parts of one end of a furnace reported slag accumulations at the basic end granular and easily removed, and estimated a slightly longer life. Parts smeared with chrome cement appeared capable of lasting indefinitely. Another operator reported no gain from the use of basic back or front walls as compared to silica-brick walls.

Maintenance

In discussing furnace maintenance, the first speaker emphasized the importance of (1) rapid rebuilding, (2) long-life construction, and (3) proper operation. Meetings should be held before a furnace is shut down, he said, to schedule work, and to lay out as much preliminary work as possible during the last hours of the last heat. When ready, the roof is knocked down into boxes in the hearth and handled by the charging machine.

Wider charging doors, basic front walls, Metalkase back walls and Metalkase base

THIS is a reprint of a Corhart advertisement in glass-industry magazines. But perhaps it will give you an idea as to how Corhart Electrocast might serve YOU. For further facts about Electrocast, turn to "Corhart," in either the Chemical Engineering Catalog, or the Metal Industries Catalog.

Re-paved Electrocast Bottom Saves Major Repair!

SOMETIME ago we published the case history of a working-end in which an old and badly worn clay bottom had been re-paved with Corhart* Electrocast, and how the Corhart sidewalls had thereby been saved for at least another campaign

Above we show a photo of that paved working-end bottom after one fire of approximately 24½ months. Note that the paving is "just as good as new"—and that after a few minor changes in sidewalls, the furnace is ready for another run! Practically no wear on the Corhart paving is apparent, and it is believed that the construction has and should contribute to improved glass quality.

Thus the Corhart Electrocast re-paving has now again saved a major repair—the original Corhart working-end sidewalls have now served for four fires approximating 7½ years—and the operator has saved the time, the materials and the PRODUCTION that would otherwise have been lost by destroying and replacing the old working-end bottom and sidewalls.

The economies represented by this type of installation are so obvious that every glass manufacturer should be interested when he knows the facts. These facts we would be glad to discuss further with you. . . . Corhart Refractories Co., *Incorporated,* 16th and Lee Streets, Louisville, Kentucky.

*Not a product, but a registered trade-mark.

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CORHART ELECTROCAST REFRACTORIES

for the roof at the back wall were recommended. Another speaker reported operating time increased 2½ per cent by proper scheduling of repairs and use of mechanical devices. A lift truck was used to load fragmentary material and a fabricated steel beam used to break up the slag slab in the slag pocket.

A method of slag removal, claimed to remove slag in a large block, in less time, and without damage to cables, etc., was described. False walls are constructed in the slag pocket, backed with silica sand, to facilitate getting at the block. The false walls are removed, the block is pried up with a steel beam, encircled with a chain and dragged from the pocket with a cable arrangement by an overhead crane.

Hot Tops and Molds

Hot-top design should be related to mold design, stated an operator in discussing this phase of ingot making. Some plants use 12 to 16 per cent as hot-top metal. The hot-top opening should be at least 70 per cent of the ingot top opening, if possible. Height to width ratio for the hot-top is probably best at 1 to 1, with a higher ratio on smaller sizes of molds.

Hot-top covers should be rugged and resistant to heat shock. The sit-on-mold hot-top was stated to be the cause of hanger-cracks in certain steels, although useful with steels not susceptible to such cracking. Permanent floating-type hot-tops are not applicable to extremely small molds. Clay hot-tops are low in cost.

Few stickers were encountered with closed-bottom big-end-up molds, it was stated. Stickers were caused by leakage around the plug. Experiments were reported to show that coating of molds had no effect upon scabs. They usually occur in the lower part of the ingot, and in rectangular ingots will appear at higher points on the narrower than on the wider faces.

—*Industrial Heating*, Vol. 10, July 1943, pp. 1040-1044; Aug. 1943, pp. 1175-1176, 1180.

Aluminum-killed Steels

Condensed from "Archiv Eisenhüttenwesen"

The particular effect of aluminum or its compounds on the fineness of the grain of a steel was reviewed in literature and investigated by new experiments with three soft steels that had been killed by aluminum. The sensitivity against overheating was tested by determining the temperature of beginning coarse grain formation at ½ hr. annealing with subsequent cooling in air.

All three steels showed a distinct decrease of the temperature at which grain coarsening starts, with increasing content of aluminum compounds, mainly alumina compounds. An effect of the content of total aluminum or metallic aluminum does not exist.

The same relation was found for the coarse grain formation at differently long annealing times at the same temperature. This relation points to the conclusion that the distribution of the aluminum compound is of importance for the size of the ferrite grain after normalizing annealing.

—H. Kornfeld & G. Hartleif, *Arch. Eisenhüttenw.*, Vol. 16, Sept. 1942, pp. 113-116.

Calcium in Steelmaking

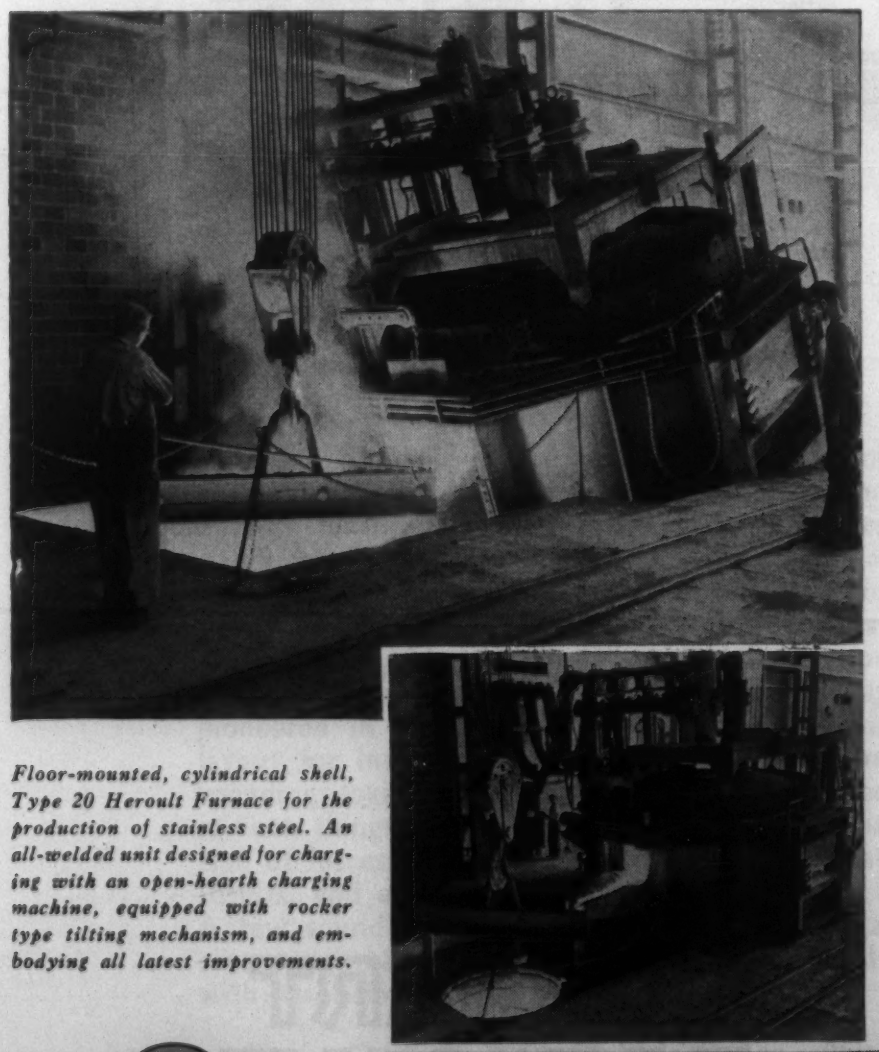
Condensed from "Metallurgia"

After briefly surveying the properties of calcium and the forms in which it occurs in nature, the author discusses the metallurgical applications of the calcium-silicon, calcium - manganese - silicon and calcium - aluminum-silicon alloys.

Calcium-silicon contains 28 to 35 per cent of calcium and, when added to molten steel in amounts of 2 lbs. or more per ton, it considerably improves its fluidity. It is employed in basic electric furnace practice to develop with maximum rapidity a highly fluid reducing slag. Calcium-aluminum-silicon contains 10 to 14 per cent, 8 to 12 and 50 to 53 of these elements, respectively. When added to steel, the deoxidation products have a comparatively low fusion point, and quickly coalesce into large particles that rise swiftly in the molten steel.

The third alloy contains calcium 16 to 20 per cent, manganese 14 to 18 per cent, and silicon 55 to 60 per cent. Its use improves the transverse strength in forged and rolled steel, as well as the ductility of steel castings.

—L. Sanderson, *Metallurgia*, Vol. 27, Apr. 1943, pp. 245-246.



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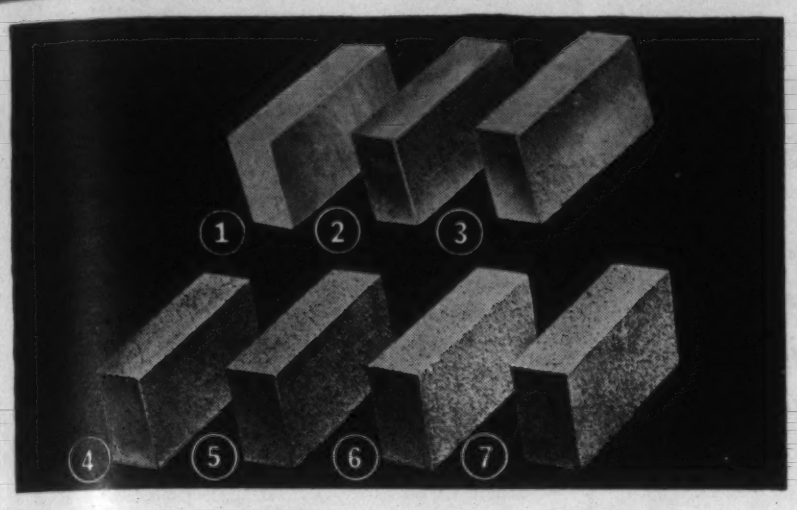

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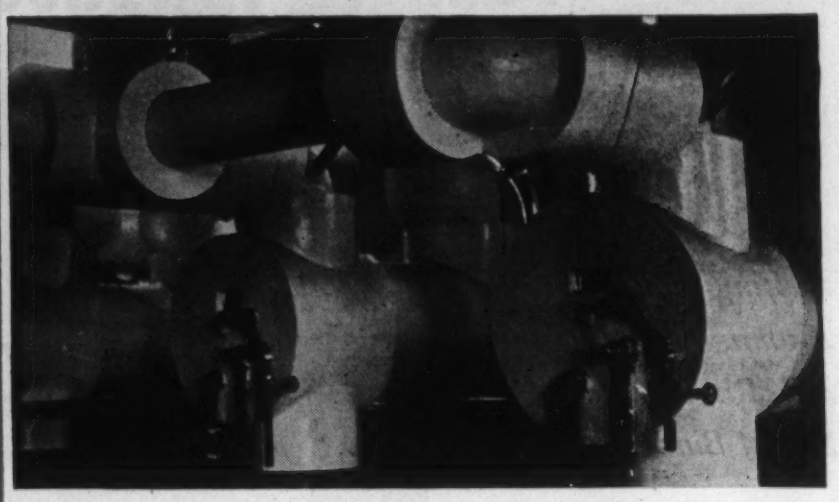

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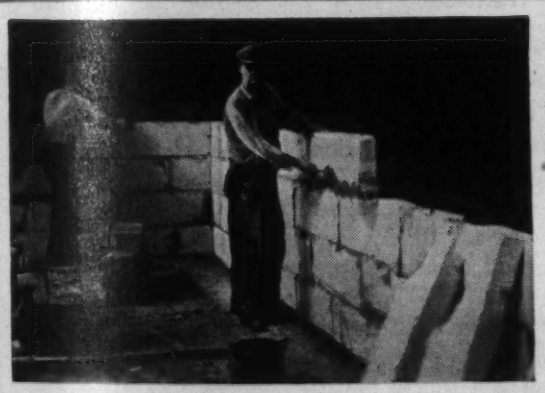

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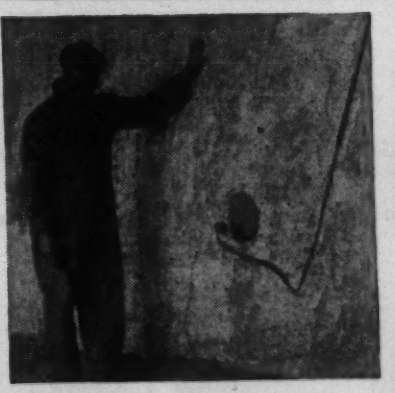

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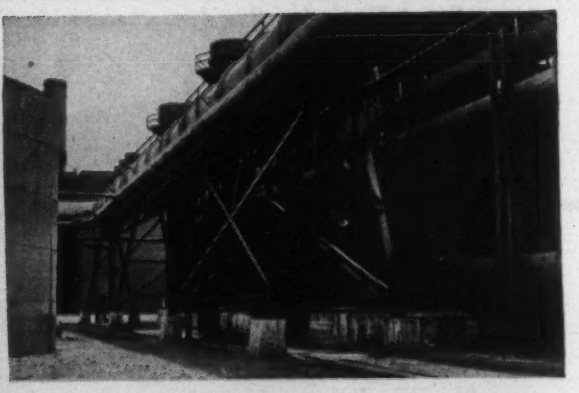

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2 Foundry Practice

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Modified Centrifugal Casting

Condensed from "The Foundry"

The method consists essentially of making the mold in the usual manner, placing it on the table, filling the mold and then the table and mold. The procedure is the closest approach to standard methods now in use in the steel foundry, and involves a minimum amount of new equipment.

Sand and mold methods are the same as when the casting is to be made statically. Gating need be no different from the usual practice, although it is more efficient and economical to use some special gating arrangement.

Although based on the same fundamentals, the details of this process differ slightly from other processes and are entirely different from those in the process when metal is poured into a rotating mold. In that case there is a directional solidification progressing from one surface only. In the process under discussion, the mold is filled before rotation and there is the action of centrifugal force during solidification, with solidification from more than one surface, usually from all four directions.

Centrifugal force tending to displace metal from the center of rotation to the periphery can be found by the following formula: $CF = \frac{W}{32.2} \times r \times (rpm \times \frac{2\pi}{60})^2$ where CF = centrifugal force is in lb., w = weight is in lb., r = radius of rotation is in ft., rpm = revolutions per min.

The fact that solidifying steel does not develop strength so rapidly is the basis of one of the major advantages of centrifugal force as a means of overcoming shrinkage during solidification. When a casting is spun, this force is exerted on every square inch of cross-section and will cause movement into any void that opens close to the periphery. Most other forces, such as air pressure, cannot affect movement of the solidifying interior without moving the solid exterior.

The benefits of this process are not only increased yield, but lower molding and cleaning costs. Contrary to assertions regarding increased density of centrifugal castings, no difference has been found in density or physical properties of well-fed cast steel, whether or not it is cast centrifugally. The only difference is in the areas showing shrinkage. Areas showing pipe or center line shrinkage in castings made by this process are much smaller.

Not all designs lend themselves to this process. The casting must be either geometrical about some point, the point to be the center of rotation, or more than one be placed around a center feeding riser. Then, the casting must be designed so that it can be fed from this one riser alone.

Finally, the casting itself must be designed for the centrifugal process. If a pattern is selected at random, the chances are that shrinkage will be more visible. Instead of shrinkage being spread out, some of it in areas of low density will be present in visible voids.

—W. F. Wright & J. B. Crane, *Foundry*, Vol. 71, May 1943, pp. 90-93, 175-176.

Conserving Foundry Refractories

Condensed from "The Foundry"

Refractories today are far better than they were in World War I. With better refractories longer life should be obtained from furnace linings.

The cupola is the heart of the foundry. One of the essential things in efficient cupola operation is the selection and proper installation of the right kind of lining. Best blocks are made from clays mined in Kentucky, Missouri, and Pennsylvania. Blocks should be made by the stiff mud, machine pressed method. Standard 9 in. x 6 in. x 4 in. blocks are the most economical for general foundry use. Some foundries using large cupolas prefer 9 x 9 x 4 blocks.

Wherever size of the cupola will permit it, a double lining of 9 x 6 x 4 blocks is preferred. This lining offers a substantial factor of safety, the cupola can be stepped up to its limit and it is easier to patch. Three-quarter in. clearance between the linings is recommended.

It was found that cupola blocks will last longer in the well and melting zone if they are laid up with super-quality refractory bonding mortar. High grade bonding mortars have a higher fusion point than the blocks.

Above the charging door 9 x 4½ x 2½ circle brick is recommended. Circle brick is preferred as it gives a more substantial job and will last indefinitely.

After lining the cupola should be dried out. This will prevent the blocks from spalling. After drying it should be put into operation as soon as possible.

After each heat some patching is neces-

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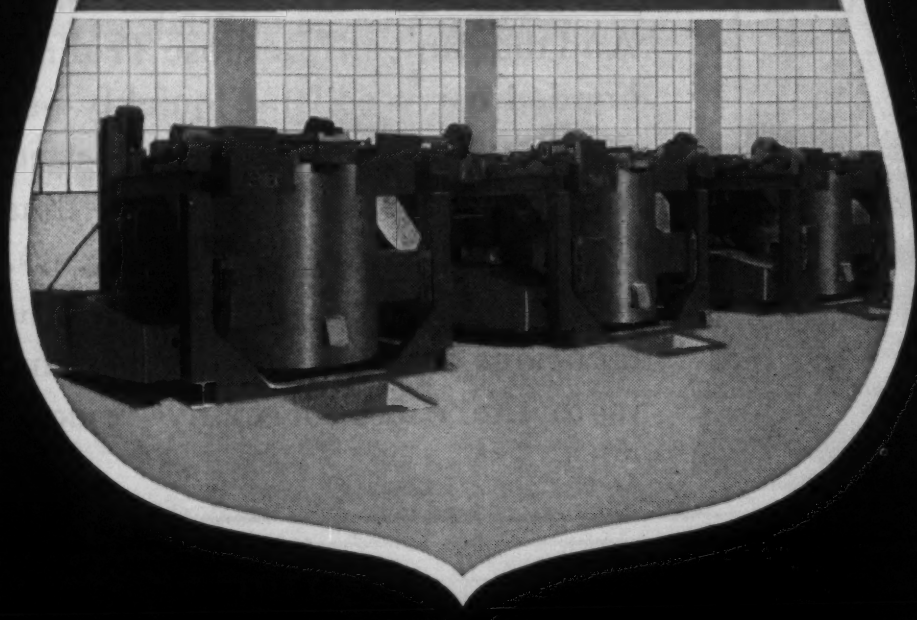

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sary. Any bumps formed above the tuyeres should be removed. All holes should be plugged with brick or refractory patching.

Daubing mud should be made from those materials which will preserve and protect the lining. Never use river sand, molding sand, yellow loam, or blue shale daubing muds.

Cupola slags are extremely variable in composition, color and physical properties. The easiest slag on the fire brick lining is one of a grayish green color and hard compact structure. Bluish, foamy slags indicate damage has been done to the lining.

Many foundries use fused soda ash as a supplemental flux. When properly used, it improves combustion, is effective in forming a fluid slag which can be removed quickly from the cupola.

Cupola lining can be preserved longer if the last charge is not coked and if the blast is shut off as soon as white heat is reached. The blast is not needed after the stock turns white.

Spouts recommended are made of trough tile.

—C. E. Bales and F. McCarthy, *Foundry*, Vol. 71, May 1943, pp. 95, 180-182.

Steel Foundry Sands

Condensed from
"Foundry Trade Journal"

This is a general survey of some practical characteristics. Molding and core practice are governed by the characteristics of molten and cooling steel, viz., high temperature > 1500 deg. C. (2730 deg. F.) fluidity, pressure and marked shrinkage and contraction (3/16 to 1/4 in. per ft.).

Both mold and core must be sufficiently refractory to prevent the deposition of a layer of the material on the casting. They must have adequate mechanical strength to withstand the pressure of the liquid steel, and yet be readily collapsible so as to offer no serious resistance to 7.2 per cent of solid contraction, which takes place on cooling.

Further, the material must possess plasticity to permit shaping, and permeability to afford the ready escape of gases. Such a combination of properties is to be found in an appropriate mixture of certain sands, consisting essentially of grains of quartz, fusion point 1720 deg. C. (3120 deg. F.), held together by bonding material such as clay.

For use as cores, the mixture invariably requires some form of organic binder. A mixture developed especially for large castings consists of highly refractory materials, such as crushed firebrick, silica sand, carbon, old crucibles, etc., bonded with fireclay, but this is gradually falling into disuse.

Recently, for green-sand castings, there has been a widening adoption of synthetic sand mixtures prepared from silica sand and clay. At high temperatures, it is a clay that begins to fail first, and that clay is best which can retain strength at the highest temperature. Each sand is a law unto itself so far as moisture content is concerned. Within the usual range, an increase in the amount of water reduces

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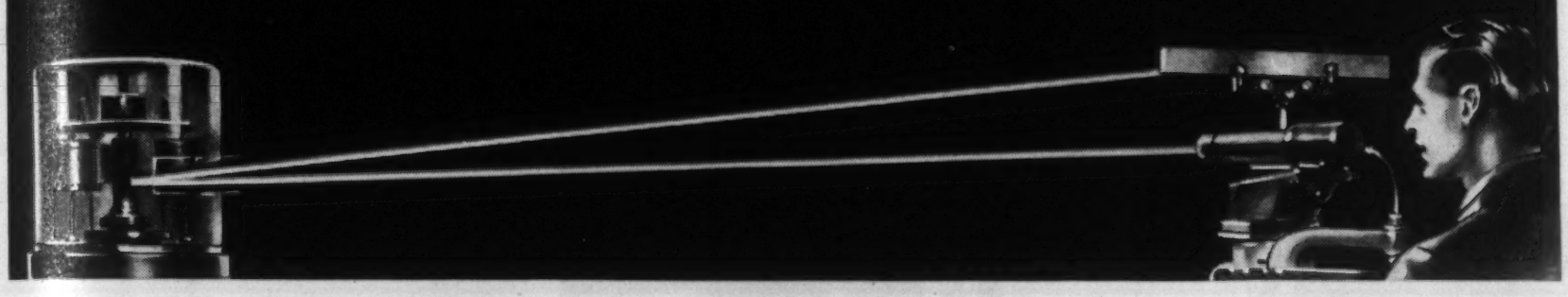

The Microphotometer is almost uncanny in its ability to look into a sample from a furnace heat of molten metal and tell exactly what elements are present in the alloy—and in what quantity. The Microphotometer does this in combination with the Spectograph. These scientific instruments are vital to the system of checks and controls in Michigan Smelting laboratories—not excelled by that of any manufacturer of ingot metals. It is this exceedingly efficient equipment that assures the most uniform specification ingots produced in this industry. Our outstanding reputation is founded on 50 years of skill, knowledge and experience. Michigan Smelting facilities are now operating 100% for Uncle Sam. Right now, we can give valuable advice and service if your products use or can use non-ferrous ingot alloys.

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the permeability and the green strength, but yields a much higher dry strength. The content which furnishes the maximum green strength is often close to that which gives maximum permeability.

Composition of the Water

The composition of the water used is of importance—alkali, lime, salt, and the like being injurious. For green-sand castings, a very high permeability is essential, say up to 200 for baking sand, average value being 180 for facing sand and 160 to 180 for baking sand.

The permeability of a synthetic sand may not be required as high as that of a naturally bonded sand, which might take a higher moisture content and, therefore, generate more steam and gas. The actual sand grains—consisting essentially of silica in the form of quartz—have a fusion point exceeding 1700 deg. C. (3090 deg. F.) *i.e.*, some 200 deg. C. (390 deg F.) higher than the casting temperature of the steel.

Silica sands usually contain at least 97 per cent of quartz, but molding sands have a lower fusion point, since their silica content is nearer 85 per cent and a portion of this is present in the form of aluminum silicates in the clay surrounding the quartz grains. Generally, clays have a fusion point lower than that of quartz, much depending on the silica-alumina ratio. Alumina has a fusion point of over 2000 deg. C. (3630 deg. F.), but with amounts up to 10 per cent the softening temperature is gradually lowered to a limit of 1550 deg. C. (2820 deg. F.). Greater proportions raise the refractoriness.

Lime, magnesia and oxides of iron also lower the fusion point. Bentonite, containing over 20 per cent Al with 3 to 4 per cent Fe_2O_3, about 2 per cent of magnesia and 1 per cent of lime, melts at about 1330 deg. C. (2425 deg. F.), while the ball clays which may contain more than 30 per cent of alumina with only 1 per cent or so of iron oxide, and even smaller amounts of lime and magnesia, often have a fusion point closely approximating that of quartz itself.

The Load Factor

Further, much depends on the load to which the sand is subjected. A sand under a load of 25 lbs. per sq. in. may collapse at a temperature as much as 100 to 200 deg. C. (210 to 390 deg. F.) below its normal fusion point. A sand deficient in flowability not only leads to an inferior casting surface but requires excessive ramming.

Flowability is influenced by the moisture content, permeability, fineness, clay content, mechanical strength, and facing material additions, and may be controlled by adjusting any one of these properties, until a suitable degree of flowability is obtained. The most important effects of grain size are those on permeability and the casting surface.

While the proportion of air space is independent of the size of uniform grains, the actual surface friction obstructing the flow of gas is naturally greater the finer the grain and thus a fine grain gives poor permeability. Further, where the grains are of many different sizes, the smaller ones tend to occupy the spaces between the large grains, and there again the permeability suffers reduction. On the other hand, a uniformly coarse grain leaves a rough surface on the castings. The best results are obtained with a grain of fairly uniform and medium size.

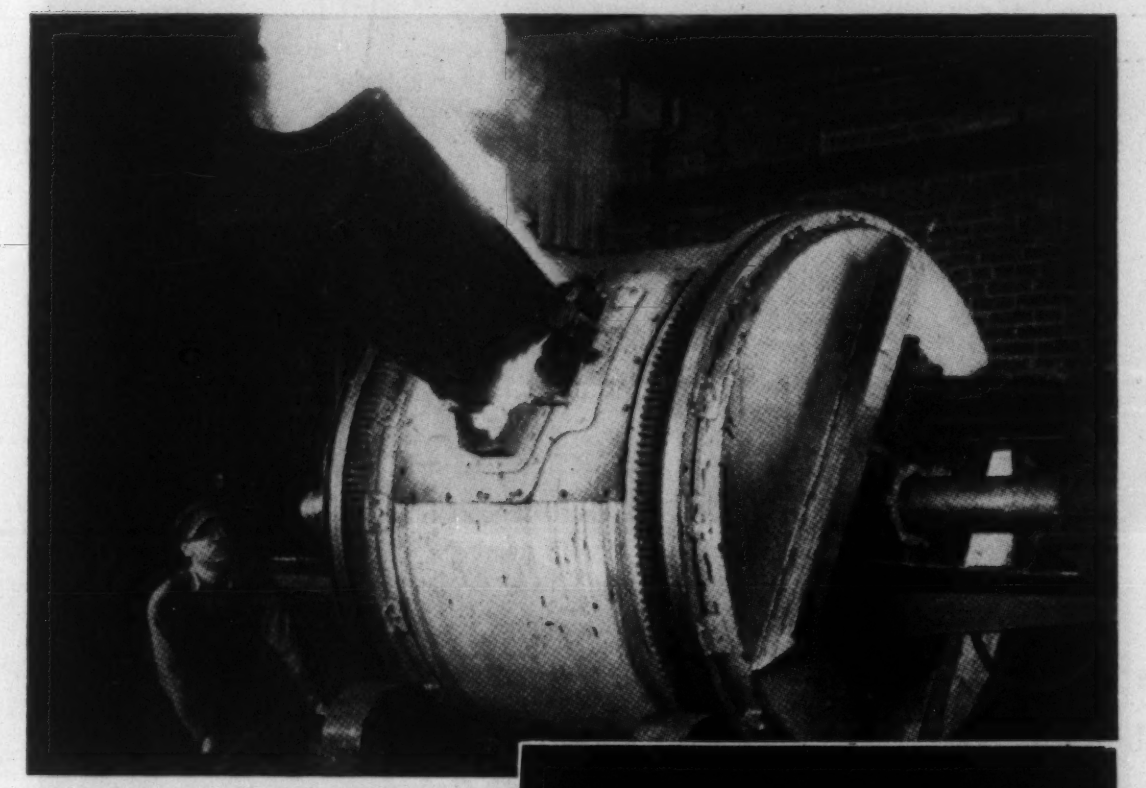
Use of Synthetic Sand

In place of natural molding sand, better results are obtained from synthetic silica sand-clay mixtures. The silica sand grains must be of suitable size, shape and surface, and the best grains are fairly uniform, sub-angular or angular, either rough or having a thin film or bond. Only a small amount of coarse grains or silt should be present.

The clay used for these mixtures must be refractory, highly plastic, and have a high dehydration temperature. Green strength depends largely on the particle size of the bond. The most plastic clay is bentonite. It gives the highest green and dry strengths, but is not highly refractory, having a fusion point of about 1330 deg. C. (2425 deg. F.). More than 3 per cent of bentonite is unnecessary, and the water content of the green mixture should not exceed 3.5 per cent.

—E. C. Pigott. *Foundry Trade J.*, Vol. 70, May 27, 1943, pp. 71-73, 77.

YOU CAN CHARGE THIS ONE TO HITLER . . .



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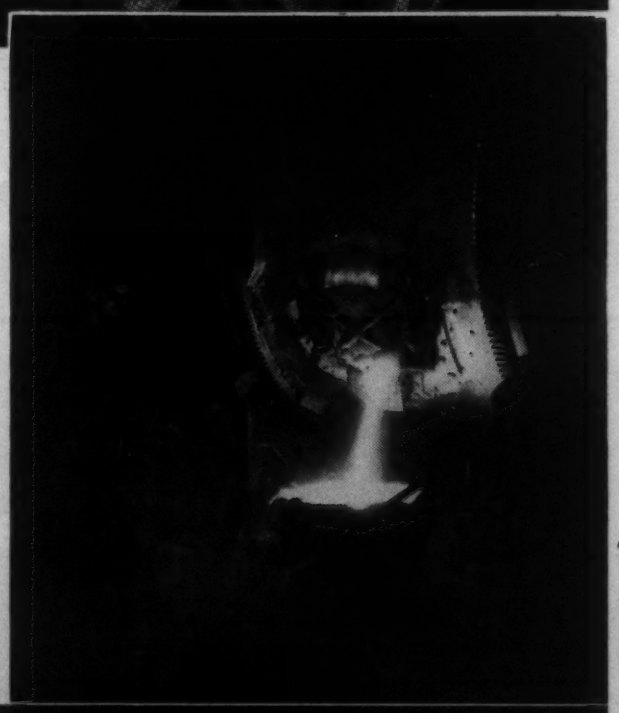

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Welding Aluminum Alloys

Condensed from "Canadian Metals & Metallurgical Industries"

All types of alloys can be welded today by some method but not all satisfactorily by all the processes available. The technique depends on the physical, chemical and mechanical properties of the parent metal.

In welding aluminum-base alloys the two most important properties are the tendency of the metal to oxidize readily and the high thermal and electrical conductivities. The effect of other properties is not negligible and metallurgical consideration of heat-treatable alloys shows that fusion welding cannot give joints equal in strength to unwelded portions.

Light alloys should be welded quickly to reduce the extent of the heat-affected zone but the thermal properties necessitate a high heat input. In fusion welding preheating is usual and resistance welding demands very high currents plus a high degree of precision control.

The oxide film, always on the surface of light metals and alloys, is a major consideration. On aluminum-base alloys the film is continuous, tough and adherent. On both aluminum and magnesium alloys the melting points of the oxide are well above that of the metals. Neither dissolves in usual borax-base fluxes nor is reduced to the metal by the welding flame or the carbon arc. An active flux is therefore necessary.

Gas Welding

Contrary to general belief it has been found that gas-welding fluxes for aluminum do not depend on the dissolution of aluminum oxide. It appears that the salts comprising flux mixtures ionize when molten and produce aluminum chloride from the metal itself. This lifts the oxide layer from the surface.

Reaction on super-purity aluminum is slow but on commercial purity metal and on many alloys it is rapid. This shows that the more continuous film of oxide on the purer metal prevents access of chloride to the metal surface. Up to 10 per cent of an alkali fluoride in the flux mixture improves the efficiency.

The mechanism of oxide removal from the magnesium-base alloys appears to be one of solution only. The mixtures most suitable are those used in the melting and casting of magnesium alloys. With certain alloys of aluminum containing appreciable quantities of magnesium, the normal flux mixtures used for aluminum require modification.

In investigating the possibility of gas fluxing it seems that the use of volatile chlorides, probably organic compounds, might be effective for the welding of aluminum alloys. Gas fluxing gives close control over the amount of flux applied. In using the normal powder mixtures, too much flux added results in undesirable inclusions. Components should be designed so that flux is not trapped in the joint. As fluxes are corrosive all traces must be removed by washing in hot water. Further treatment in 5 per cent nitric acid may be necessary.

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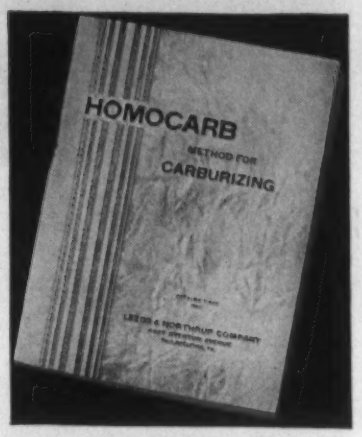

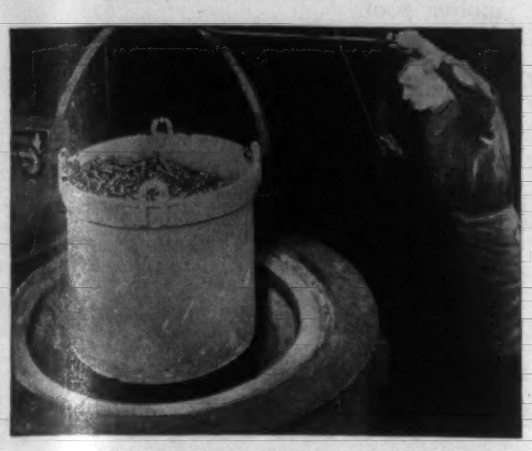

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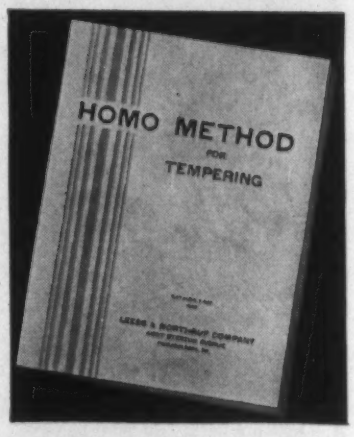

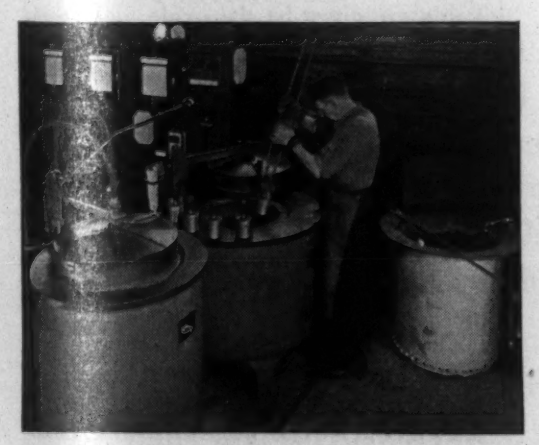

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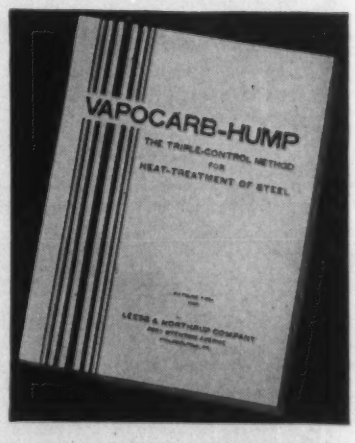
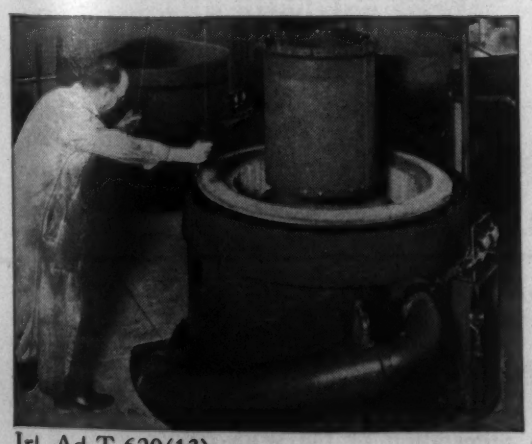
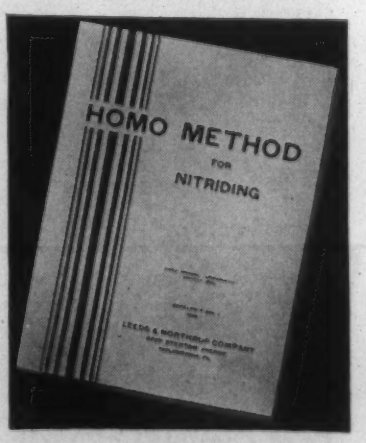
The Vapocarb-Hump Method gives the heat-treater three precise controls. Vapocarb atmosphere control protects surfaces during heat-treatment, eliminates scaling, pitting and decarburizing . . . cuts refinishing. Rate-of-heating control brings all parts of the work through the critical slowly and uniformly . . . keeps residual stresses low, minimizes warpage and resulting rejections. Quench-point control enables the heat-treater to get exactly the structure and depth of hardness he wants for the particular tool treated. Altogether, these controls add up to give lower finishing costs, longer tool life and less rejections. For full details, write for Catalog T-621.





HOMO NITRIDING

In Homo Nitriding, case develops evenly at a predictable rate under complete control of the heat-treater. He regulates flow of ammonia gas, temperature and time, to give the maximum nitriding rate . . . gets the case he wants in every heat and in every part of the heat. Homo forced-convection heating keeps temperature uniform throughout all parts, even of dense loads, and covers each surface with an ample supply of nitriding gas. Parts are loaded without need for stacking; heating to soak is rapid; and at the end of a run parts are cooled quickly in nitriding atmosphere, as furnace gas flows through a water-jacketed cooling manifold. Full details in Catalog T-624.



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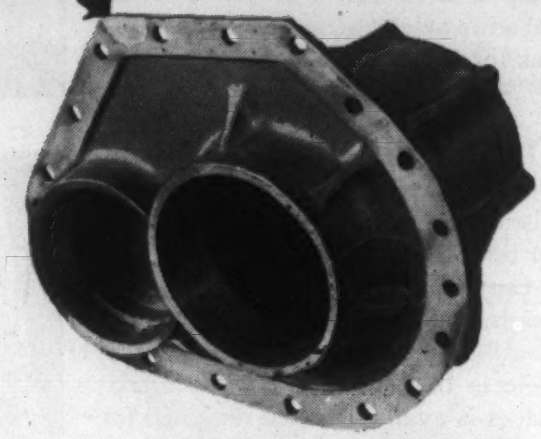
EUTECTIC
(Means Lowest Binding Alloy)
LOW TEMPERATURE WELDING

SALVAGING DEFECTIVE ALREADY-MACHINED CASTINGS



WITH MACHINABLE EUTECTIC "COLDARC" ALLOY No. 24

PROBLEM

Salvaging already-machined cast-iron, malleable iron or chrome-nickel alloy steel castings having porous spots or machining errors. . . . When ordinary electrodes were used a hardened fusion line generally resulted. Naturally, this caused great difficulty and time-waste in machining the welded sections.

SOLUTION

Eutectic "Coldarc" Alloy No. 24 (AC-DC). This new kind of electrode can be applied at low heat —without preheating—without deep fusion of the parent metal. Eutectic "Coldarc" Alloy No. 24 gives perfectly *color matching*, *easily machinable* welds on all ferrous metals. It has been saving hundreds of thousands of dollars in foundries, tool shops, ordnance plants, etc.

Only "Eutectic* Alloys" are the true Low Temperature Welding Alloys that are revolutionizing production welding, maintenance welding and salvaging in war plants throughout the nation. There are 42 specialized rods for every metal and every welding job. Developed and manufactured only by Eutectic Welding Alloys Company.
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Atomic Hydrogen and Heliarc Welding

The atomic hydrogen torch for light alloy welding gives good heat concentration and high flame temperature but does not reduce the oxide on aluminum, so flux is still required. To be used to full advantage automatic operation is necessary.

This process, originally developed for magnesium alloys (See METALS AND ALLOYS, August 1933, p. 302), uses a protection envelope of helium with an arc struck between a tungsten electrode and the work. In the torch the helium passes through an annular space around an adjustable electrode.

Direct current up to 150 amps. is used and welding speeds up to 3 ft. per min. are claimed. Arc lengths should be less than 0.06 in. The rod is held at an angle of 60 to 90 deg. to the electrode and allowed to play on the filler rod not the molten pool.

For magnesium alloys no flux is required but it probably will be for aluminum. Hydrogen, oxygen, carbon dioxide and hydrocarbons must be absent from the helium and 7 per cent nitrogen reduces the welding speed 60 per cent of that when only 2 per cent is present. The specific heat of helium (1.25) allows a valuable quenching effect on the surrounding metal.

Arc Welding

The metallic arc process is valuable because of the high heat concentration which allows rapid welding and gives a heat-affected zone of negligible width. The unstable arc given by the oxide film necessitates a special flux coating which must not only remove the oxide, but stabilize the arc, not melt at too low a temperature, and give a readily removed slag. Recent work has produced satisfactory electrodes capable of depositing sound welds particularly when the parent metal is pre-heated to a minimum of 150 deg. C. The process has been applied to pure aluminum, aluminum-silicon alloys and aluminum-magnesium alloys. Its present limit for wrought alloys is the welding of sheet thicker than 12 gage.

The carbon arc has been used to a small extent but it is difficult to avoid porosity and some pre-heating is general. The "Weibel" process is limited in application to straight seams. The edges are flanged and the electrodes drawn along them. The flanges must be accurate or the electrodes stick. The "Technotherm-Rakos" process overcomes this difficulty by using a single carbon electrode.

Resistance Welding

The spot-welding process is being increasingly applied not only to non-stressed components but to certain primary-stressed parts. The most important aspect is the preparation of the work before welding—*i.e.* the fit of the parts and the surface condition.

The components should be held by tack welds, rivets, clamps, etc. The work should be placed between the electrodes in a horizontal position to avoid spot welds near the edge and space them correctly. The oxide film on aluminum-base materials is unsuitable for spot-welding because of its high electric resistivity. Therefore the metal must be degreased.

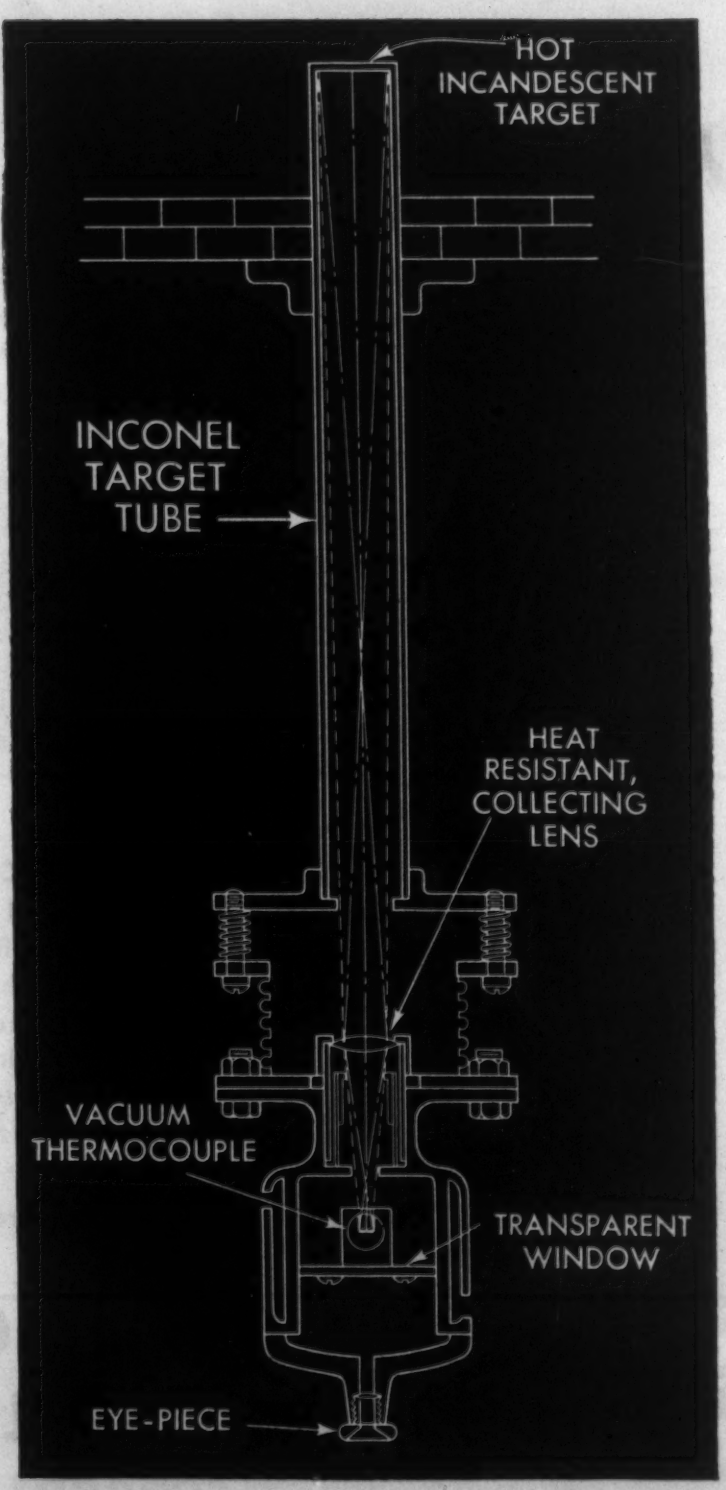
*INCONEL Target Tubes assure accurate high-temperature measurement by Wheelco Heat-Eyes

On brazing furnaces with hydrogen atmosphere, on high temperature hardening and heat-treating furnaces, and on other furnaces where temperatures go above 1800° F.... furnaces with atmospheres that might cause deterioration of a conventional thermocouple . . . Wheelco Heat-Eyes are used for control and measurement.

Heat rays pass *first* through an Inconel target tube to a lens which focuses them on the remote vacuum thermocouple, as shown in the diagram.

The Inconel tube (1) resists the high temperatures encountered (2100° to 2300° F.); (2) withstands the corrosive effect of hot gases present in the furnaces; (3) provides a rigid support at high temperatures for the Heat-Eye assembly, thus assuring accuracy in the measurement.

This combination of strength, heat resistance and corrosion resistance makes Inconel ideally fitted for service where all three of these properties are essential.



* The details of this use of Inconel, a wrought nickel-chromium, heat-resistant alloy, are published in the belief that they will be of interest and value to engineers and designers working on similar problems, though the use of Inconel today is subject to conditions imposed by the War.

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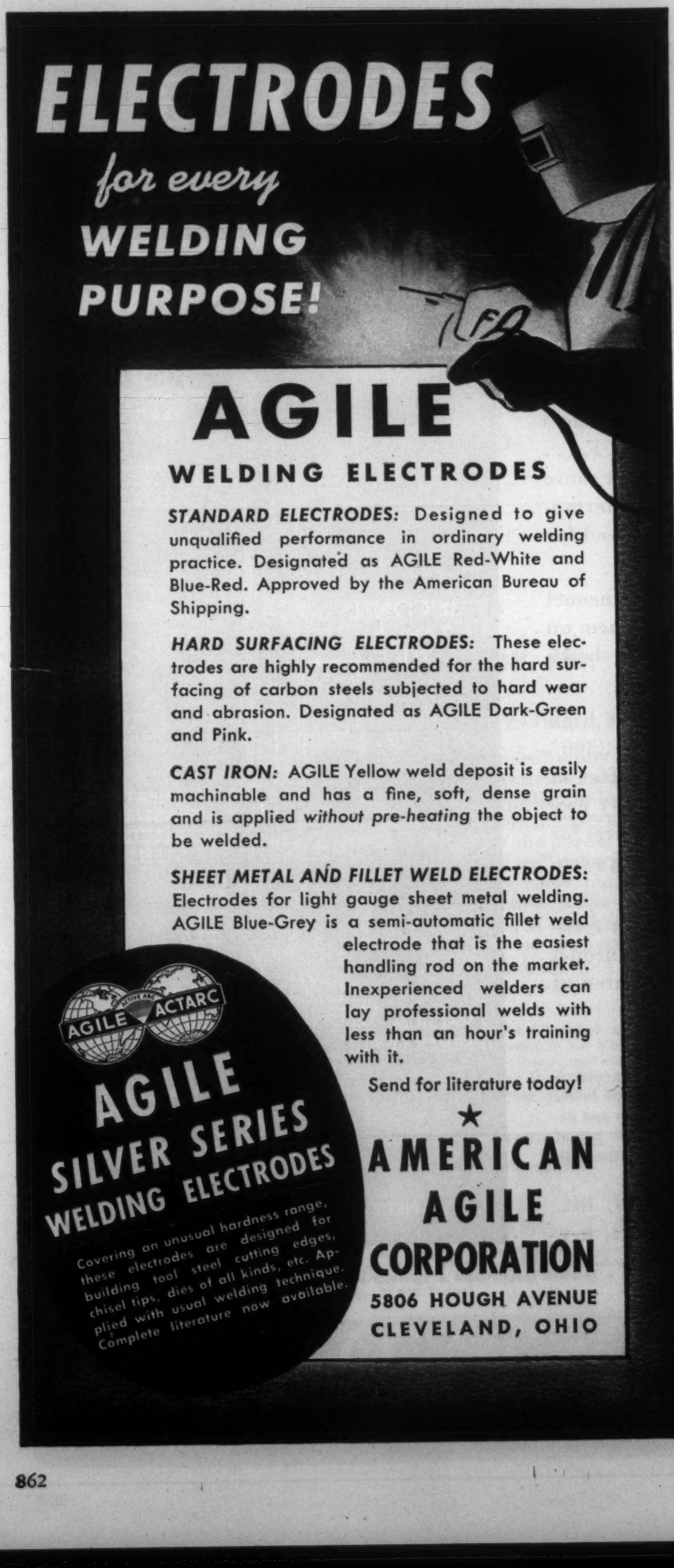


For large scale productions, pickling is recommended. The latest solution employs phosphoric acid at normal temperature. After pickling, articles should be spot-welded as soon as possible.

Check tests on spot-welded samples, usually a tension-shear test, should be made at regular intervals. Metallurgical examination of representative spot welds is also invaluable. An important aspect of metallographic testing is to assess the depth of penetration of the weld into the sheets. The optimum figure is usually about 2/3 of the total thickness for sheets of the same gage, or 2/3 of the thinner, when the thicknesses are different. More research on the fatigue properties of light alloy welds is required.

—E. C. West. *Canadian Metals & Metallurgical Inds.*, Vol. 6, July 1943, pp. 32-34, 54.

Electroplating Safety Hazards

Condensed from "Products Finishing"

Records of the National Safety Council show that 18,500 workers were killed on the job in 1942. In addition, there were 1,750,000 non-fatal occupational accidents. It is very important that the loss which these accidents represent be reduced.

A successful industrial safety program is necessarily a cooperative effort on the part of both management and labor, plus the individual resolution of each man to keep constantly safety-conscious.

The most common hazards of electroplating are poisoning from fumes and affections of the skin. The latter include burns and dermatitis. Inhalation or absorption through the skin of hydrocyanic acid gas may result in acute poisoning. This gas is formed by the accidental mixing of cyanides and acid.

Preventive measures against these hazards range from an overall plant program to the individual carefulness of each worker, and from the use of an efficient ventilating system to keeping containers of poisonous supplies marked "Poison."

Floors of electroplating rooms should be made of a smooth water-tight material and should slope to a central drain. Adequate and convenient washing facilities should be provided. A water fountain is a convenient first-aid tool for cleansing eyes that have been affected.

Suitable safety clothing, such as rubber boots, gloves, aprons, etc., acid-proof hoods and splash-proof goggles are all important and should be used.

Bright-dip tanks and other acid cleaning equipment should never be operated without good exhaust systems. Men should never enter a vapor degreasing tank without airline respirators or hose masks, and a life-line and attendant outside the tank. First aid and medical care are important when a worker suffers from any injury or ailment.

The foregoing discussion is not intended to present a comprehensive safety plan for the metal finishing industry. The purpose of the article is chiefly to emphasize the need for a systematic and thorough safety program in every plant. Constant safety-consciousness not only will "Save Manpower for Warpower," but also will contribute to the workers' own health and welfare and that of others.

—Clark Bridges, *Products Finishing*, Vol. 7, April 1943, pp. 48-54.

High Frequency Heat Treating

Condensed from
"Electrical Manufacturing"

Induction heating is used for annealing, forging, melting, surface hardening, brazing, etc. Electrostatic heating has two general applications, the heating of non-metallic materials and the bringing about of chemical reactions, as in drying paper or foods, setting of resins, bonding of plywood, and protection of food from infestation. High or radio frequency currents are employed in both induction and electrostatic heating. In one case there is produced a magnetic field within a coil, while in the other there is an electrostatic field between plates or electrodes. Frequencies range from thousands of cycles per second, kilocycles, to millions of cycles per second, megacycles.

Frequencies from 1 to 12 kc. in power ranges from a few watts to thousands of kw. are produced by rotary generators; frequencies from 50 to 200 kc. with power outputs up to 25 kw. may be generated from spark-gap oscillators, and frequencies from 150 kc. to 30 mc. and power outputs up to 200 kw. have been generated with vacuum tube oscillators.

Today's vacuum tube generators are rugged and reliable. Tube life is of the order of 10,000 hours operation. It operates at frequencies sufficient for the induction heating of both magnetic and non-magnetic material as well as for electrostatic heating.

Applications

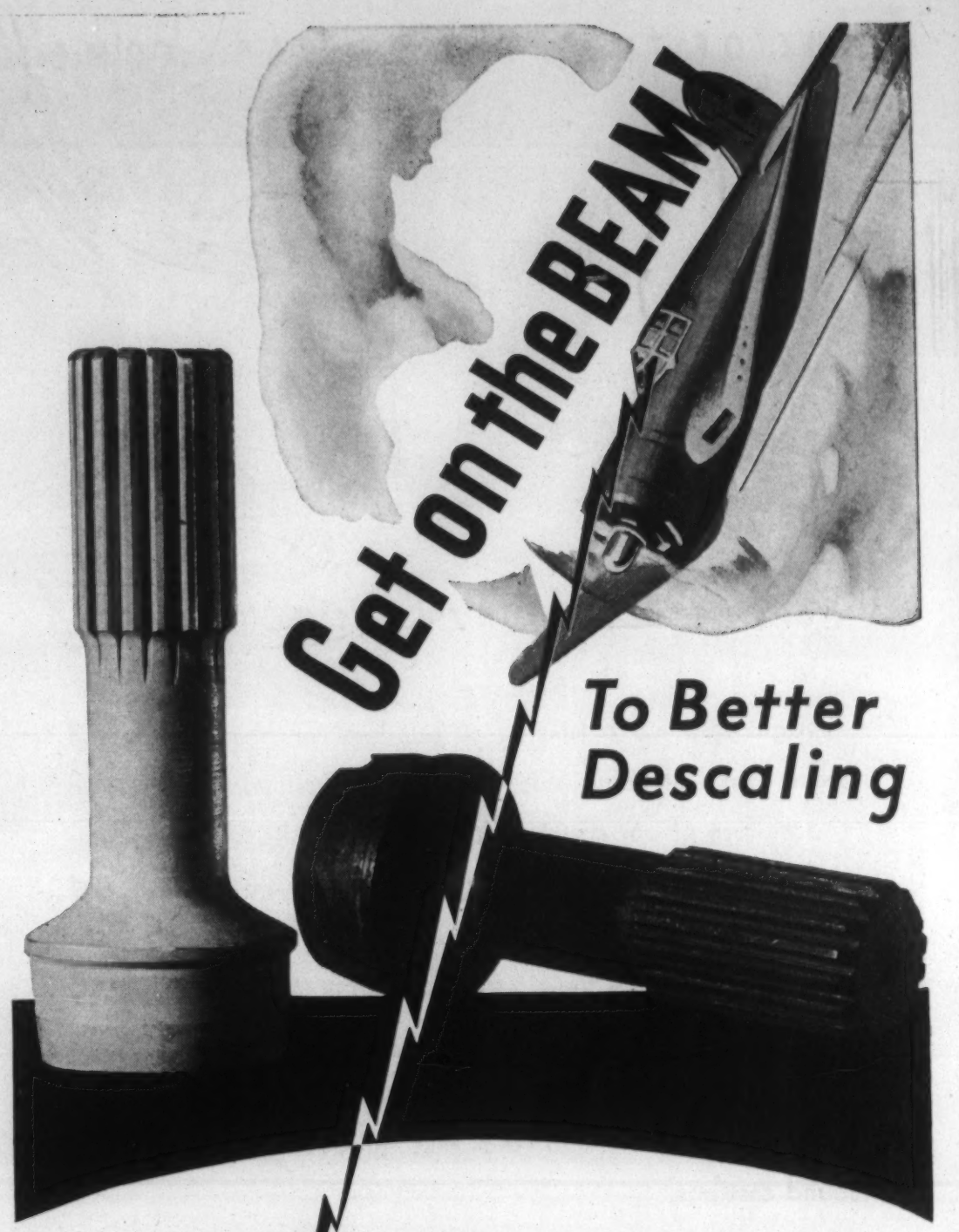
For packing acid foods, as tomatoes, only tin plate can be used on steel containers. Electrolytic plating saved about 66 per cent of the tin required for hot dipping, but gave a granular gray surface, thin in spots. By passing the plated strip through a rectangular inductor coil, carrying 200 kc. current, the tin is flowed in 0.6 sec., increasing corrosion protection.

Because of skin effect it is possible to heat surface portions of a piece of metal placed within a coil carrying radio frequency current, before the metal interior becomes highly heated. The surface may thus be hardened without disturbing the state of the interior metal. It appears to be most economical to produce cases a few hundredths of an inch deep. Such cases can be controlled to within 0.001 in., using 5 mc. energy, which makes it possible to finish to final dimensions before heat-treat. It is usually desirable to limit current flow to about one second.

Completing the heat treatment in one second produces no scaling in ordinary atmospheres. Use of too low a frequency or a slow heating rate may require 15 seconds or more to bring the surface of a part to temperature, with consequent over-deep and nonuniform case thickness. For the surface hardening of relatively large parts where considerable depths of case are preferable, frequencies as low as 12 kc. may be of value.

Because of its cleanliness and high speed, r.f. induction currents make successful brazed and soldered joints. Tin cans, heads in shells, etc. are being handled in this way.

A frequency of 1 kc. is used for forging and melting steel and non-ferrous



The Bullard-Dunn Process, the "up-to-the-minute" descaling method, meets the stringent requirements of war-time production because it lowers descaling time; it saves labor; it removes scale completely from internal as well as exposed surfaces; it changes no dimensions; it is dependable; it is easy to operate; it is practical. What more can one ask for present as well as post-war production?

Send data and representative samples to

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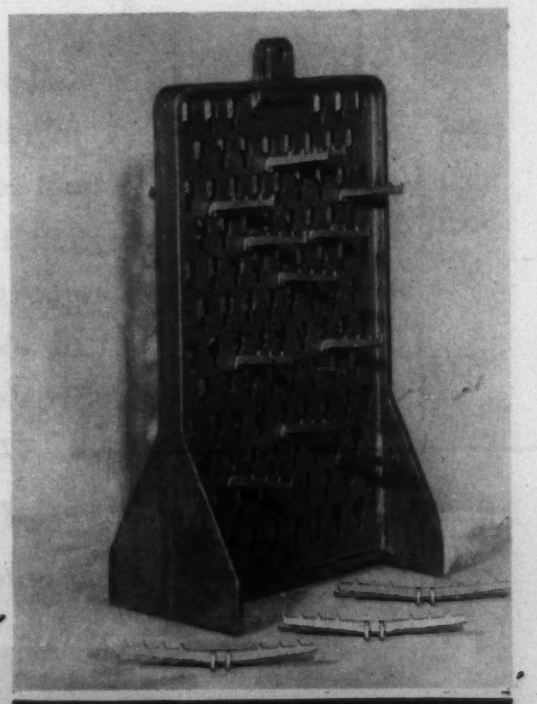
Right now we're turning all our heat on the Axis... and we're proud of being able to make material contributions to the welfare of our country. Yes, Sterling Alloys castings are being furnished to our Government... to Lend-Lease... and to most of America's major industries.

Such a responsibility is characteristic, however, because it's a job that should be handled by men of competence... men with the "know-how" of making metals that will work under high temperatures, and the fast production of accurate, sound castings.

It's quite possible your operations can be improved by the use of "alloys which will work when hot"... Write our Engineering and Design Service, outlining your particular problem, and we'll submit suggestions and quotations, or our engineers will call.



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metals. From 1 to 12 kc. are used for forging, surface hardening of large parts, commercial melting, preheating and annealing of steel and non-ferrous metals, and for brazing and soldering. Current from the new 9,600 cycle generator is used for brazing and soldering and for surface hardening small parts. Induction heating also embraces the ranges 50 kc. to 1 mc., these frequencies permitting the use of higher flux densities in heating low-resistance metals like silver, aluminum, copper and brass. From 5 to 15 mc. is recommended for most heating applications.

In heating plastics, wood, or other dielectrics, frequencies above 1 mc. are commonly employed. The heating effect is due to dielectric hysteresis or molecular friction.

—*Electrical Manufacturing*, Vol. 32, July 1943, pp. 112-115, 160, 162, 164, 166, 168, 170, 172.

Cadmium Plating

Condensed from "Monthly Review," American Electroplaters' Society

Among the advantages in favor of electroplated cadmium as compared with zinc as a corrosion protective coating on steel are: (1) It is more easily soldered; (2) it has a better appearance; (3) cadmium plating solutions are easier to maintain; (4) it can be deposited faster than zinc; (5) its electrical resistance is lower than that of zinc; (6) in a saline atmosphere it gives better corrosion protection than zinc.

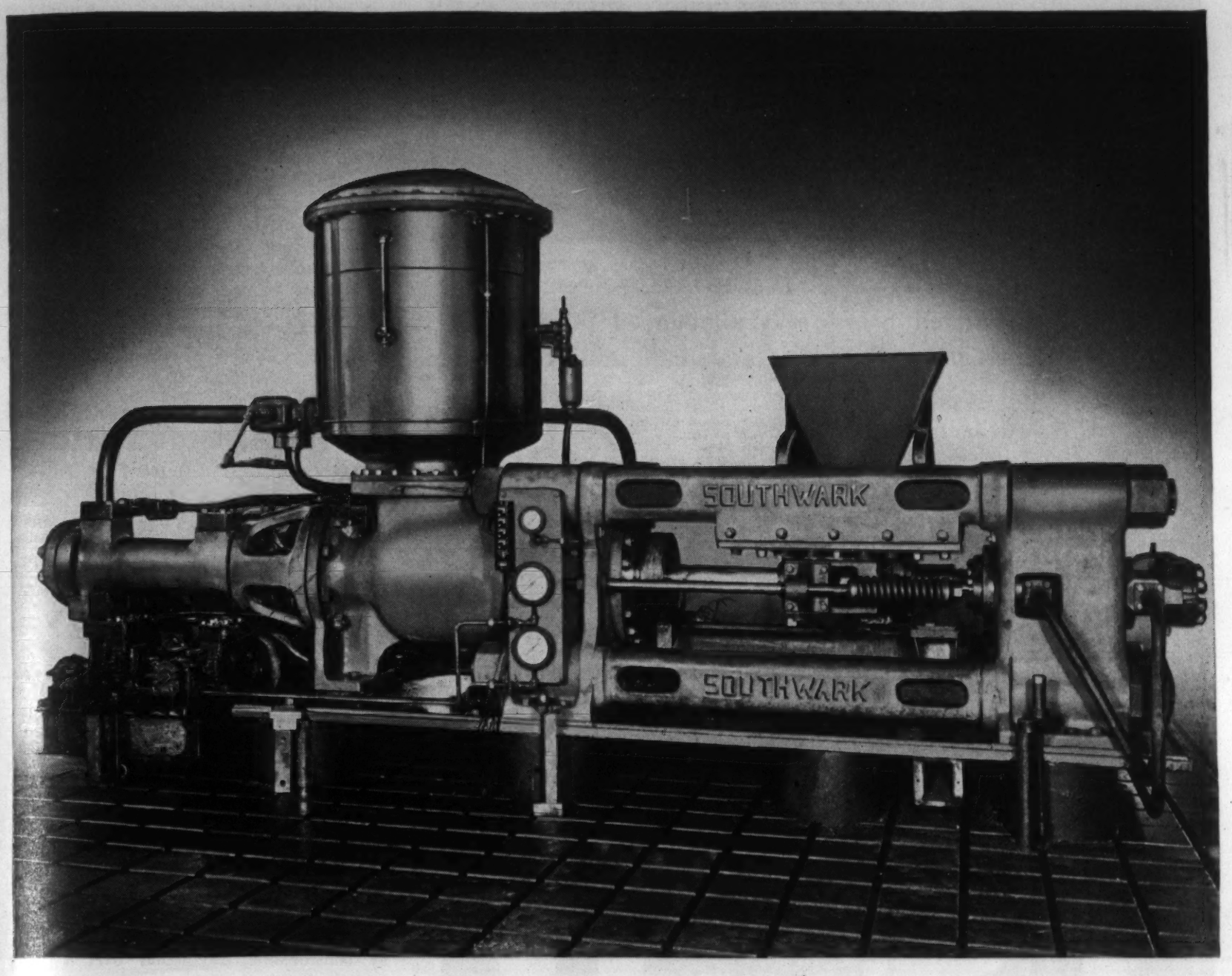
The cyanide type of solution is usually used for cadmium deposition. The solution is made up from cadmium cyanide and sodium cyanide. Caustic soda, sodium carbonate, and ammonia are formed during operation of the bath. The concentrations of the constituents may vary widely depending on the application. If a high throwing power is important, a low cadmium concentration and a high cyanide concentration should be used.

The low cathode current efficiency of such a solution makes long plating times necessary if thick deposits are required. Under these conditions rough deposits are likely to be obtained. Therefore filtration of the solution and bagging of the anodes is required. Since the anode efficiency is likely to be higher than the cathode efficiency, the cadmium concentration tends to build up. This may be prevented by replacing part of the cadmium anodes with steel anodes.

Best results are obtained when the pH of the bath is maintained between 12.0 and 13.0. Above and below these values adhesion is less satisfactory.

Without the use of addition agents it is difficult to operate a cadmium bath at cathode current densities above 15 amp. per sq. ft. Addition agents improve the appearance of the deposits, the throwing power, and the bright range of the solution. Dextrin, starch, caffeine and Postum have been used and commercial brighteners are available.

A bright dip is usually used after plating to give the plate greater luster. Either chromic acid, a sulphuric acid-hydrogen peroxide solution, or a 1 per cent nitric acid solution may be used as a bright dip. The chromic acid dip increases slightly the protective value of the deposit. The cadmium coating often dulls within a



PLUS PROFITS from your machine shop SCRAP

Today with scrap metal holding a high place on the list of critical material, many War plants have installed Baldwin Southwark briquetting presses. Producing from 5 to 7 steel, or 12 to 18 cast iron briquettes a minute, this fully automatic Baldwin Southwark press serves a dual purpose; not only for effective handling of cast iron borings and steel turnings but also by lending itself to more efficient and economical remelting of this War essential scrap.

Just another example of special machinery designed and constructed by Southwark engineers.

Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia, Pa.; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco, Calif.

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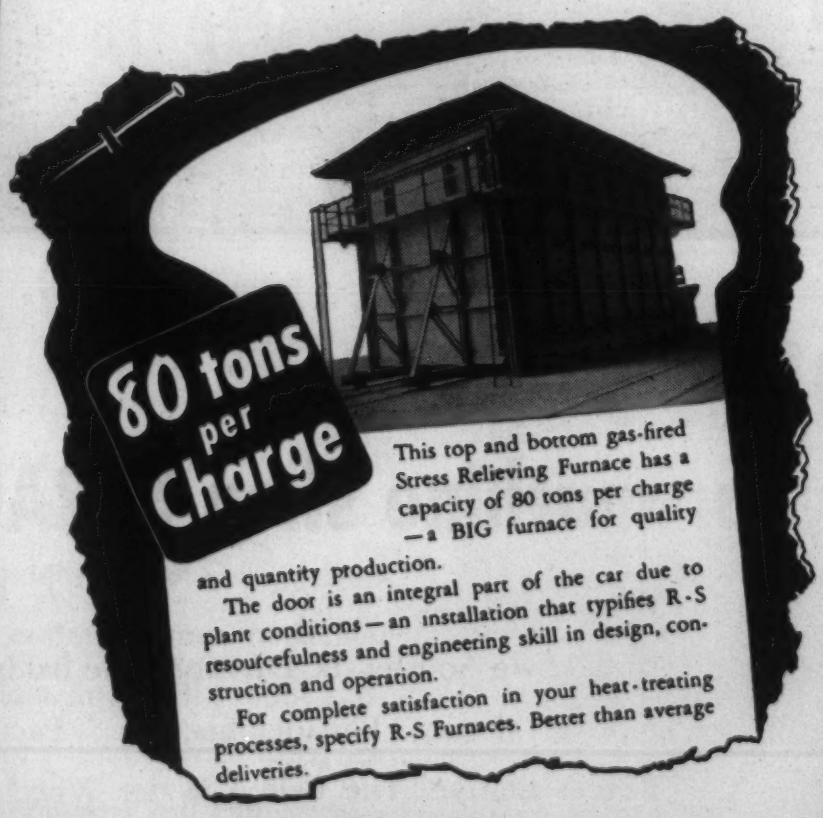
One year ago, the Stress Relieving Furnace illustrated below was announced in the trade press. Delivery was prompt and during the past year, operating performance has been very satisfactory. The operators report, "A well-engineered installation that has given us no trouble whatsoever."

A repeat order resulted, a common occurrence when R-S Furnaces are installed.

Here, then, is tangible "proof of the pudding." Smaller R-S Furnaces for any heat treating service are equally satisfactory. You can always bank on R-S Furnace performance.



This top and bottom gas-fired Stress Relieving Furnace has a capacity of 80 tons per charge —a BIG furnace for quality and quantity production.

The door is an integral part of the car due to plant conditions—an installation that typifies R-S resourcefulness and engineering skill in design, construction and operation.

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BUY WAR BONDS

short time when the nitric acid bright dip is used.

Silver, lead, tin, antimony, and arsenic are detrimental to a cadmium plating solution. Thallium in the anodes will cause dull deposits. Chromic acid in the solution causes flaky, blistered deposits and may reduce the cathode current efficiency to zero. Impurities may be removed by plating dummy cathodes at a low current density, or by adding cadmium sponge or zinc dust, followed by filtration.

Defective cadmium may be stripped with a solution of ammonium nitrate or hydrochloric acid, containing antimony trichloride as an inhibitor. Cadmium is extremely poisonous and must not be applied to food containers.

—Zachary Irenas, *Mo. Rev. Am. Electroplaters' Soc.*, Vol. 30, July 1943, pp. 603-608.

Stretch-Press Form Blocks

Condensed from "American Machinist"

Wood, cast iron, Kirksite, Masonite, cloth base phenolic resin bonded materials like Banelyte or Insurok, concrete, and cast plastics may be used in the construction of blocks to form sheet metal in stretch presses. The major factors governing the choice of a proper material are: (1) quantity of parts to be formed, which is usually the primary factor, (2) configuration, and (3) strength of the block.

For limited production, which in certain cases may reach 1000 pieces, well seasoned wood is satisfactory. Kirksite will stand up well for runs up to about 4000 parts, if there are no points of extreme pressure. Only limited lubrication of the die surface is necessary with this alloy because of its inherent greasy nature; therefore, speed of operation is promoted. Polished cast iron blocks, which are practically permanent equipment, are warranted by considerable production over a long period of time.

The use of Masonite is advisable only in rather "chunky" blocks which require little hammer work on the sheet while it is being stretched, since Masonite tends to disintegrate under impact on its edge grain. Masonite has the advantage of being practically impervious to water so changes in humidity have no effect on size and shape of the block.

Concrete and cast plastics may be used for the same type of blocks as Masonite. Cloth base phenolic resin bonded substances, particularly those impregnated with graphite, are excellent from the standpoints of wear resistance, workability and constancy of contour.

Wood laminations wear excessively where there are sharp ridges or other high pressure points. Therefore inserts of cast iron or graphited cloth base phenolic material should be used in these positions.

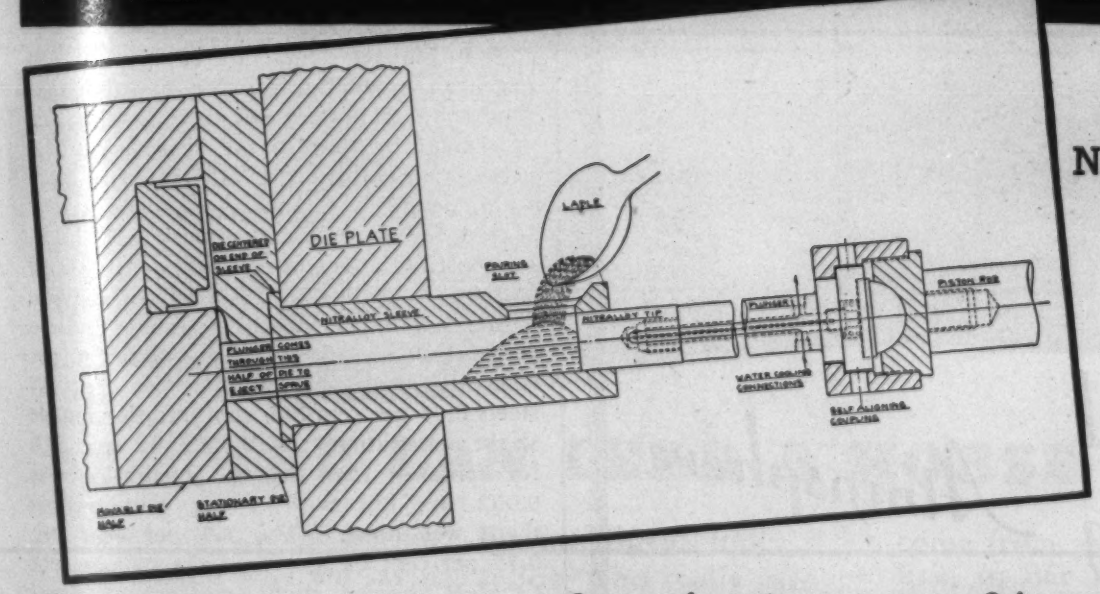
The load on the block is a function of the material to be stretched and its thickness. Wood blocks, if properly supported, will withstand the load of stretching 0.081 in. thick 24 SW aluminum alloy sheet. Kirksite is not nearly so susceptible to deflection as wood and some overhang of the table may be allowed.

Because of the relatively high strength of gray cast iron, blocks made from it may be designed with a solid top and a base ribbed for strength. (In some cases, Kirksite may be cast in a similar manner). Plastic

FOR DIE CASTING ALUMINUM

For production of aluminum castings of uniform density, the Reed-Prentice 1½G Die Casting Machine has been thoroughly proven in many installations. High pressures effectively eliminate all porosity and assure castings of more density and strength. This machine is of the cold chamber type, hydraulically operated, and arranged for both manual and semi-automatic operation.

Reed-Prentice Machines are also adaptable for use with brass and magnesium. Model 1½ for zinc only. Our sales engineers will gladly discuss with you your die casting problems.



PROMPT DELIVERY

No. 1½G Machines available for delivery in early November.

Cut at left shows method of ladling and injecting metal. Die plates are arranged so that automatic ejection of castings and core-pulling attachments may be provided.

Specifications - 2" Plunger

Size of die plates	28" x 29"
Space between bars	15" x 18"
Max. thickness of die handled	18"
Die opens	10"
Locking pressure	130 tons
*Capacity per shot	25 cu. in.
*Pressure on metal	9,000 lb. per sq. in.

* Capacities and pressures can be varied, dependent on diameter of plunger used, up to 2½".

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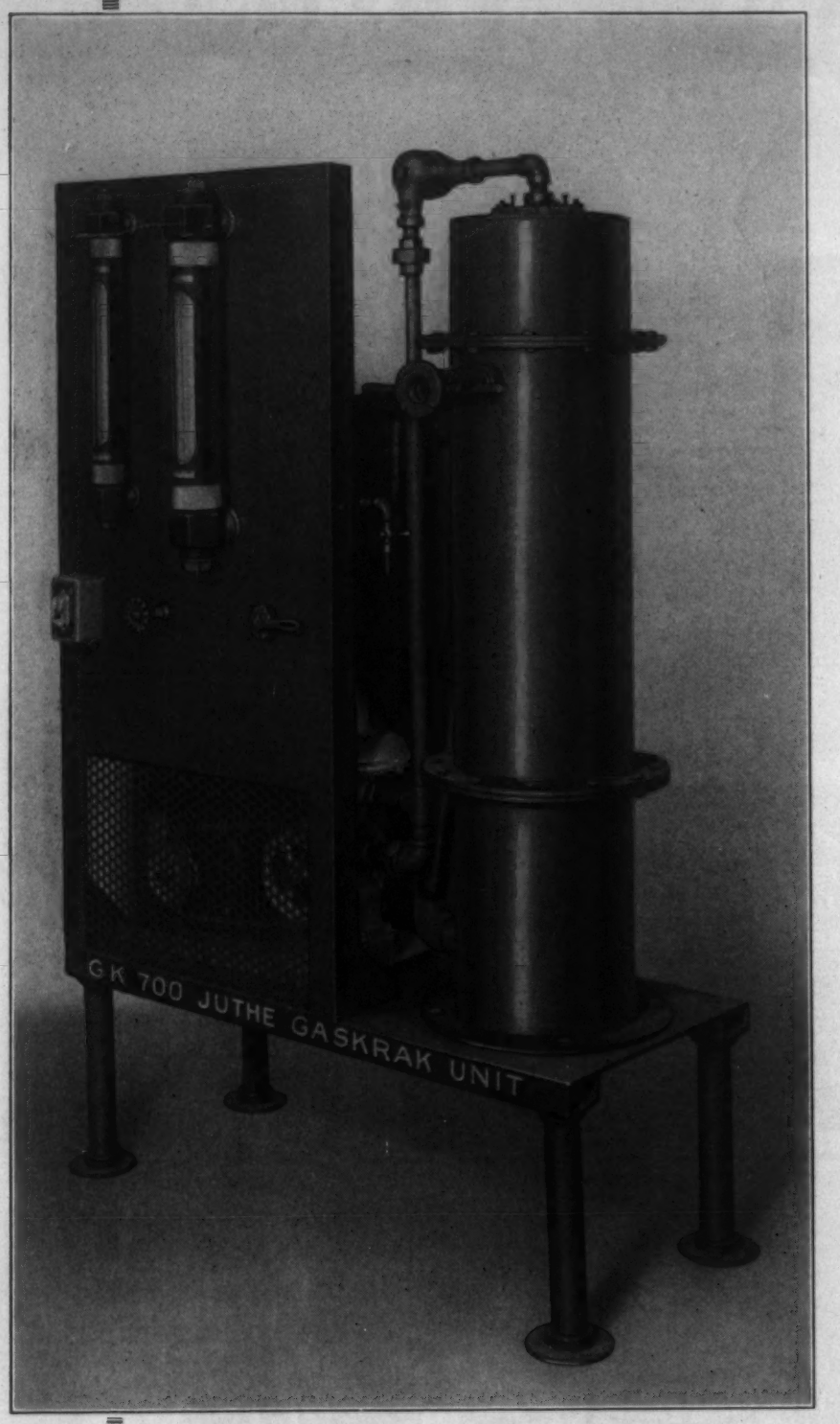

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and concrete blocks should have reinforcing bars on the tension side. Cast plastic blocks must also be supported by a rigid structure on the underside to prevent chipping of the lower edges.

—C. L. Fenn, *Am. Machinist*, Vol. 87, Aug. 5, 1943, pp. 83-86.

Sulphur in Furnace Atmospheres

Condensed from "Metallurgia"

Watergas plants and small producers are being installed in steelworks where the town's gas supply is inadequate, and since the auxiliary equipment for sulphur removal represents a large proportion of the plant's cost, its necessity was questioned. The information presented has been obtained in a study of high-temperature oxidation of plain and alloy steels at Leeds University.

When the products of combustion of the fuel constitute the furnace atmosphere and are in contact with the heated metal (1) addition of sulphur dioxide to the furnace atmosphere greatly increases rate of oxidation and forms iron sulphide in the oxide scale; (2) at tempering and hardening temperatures (1200 deg. to slightly below 1650 deg. F.) the sulphide is distributed as separate particles throughout the scale; (3) at higher temperatures a molten oxide-sulphide complex is formed, which penetrates into the metal along the grain boundaries; (4) free oxygen in the furnace atmosphere prevents the formation of sulphide in the scale; (5) it cannot be assumed, without knowledge of the furnace design, that excess oxygen in the combustion of the fuel indicates free oxygen in the furnace atmosphere; (6) the rate of oxidation of steel increases exponentially with temperature.

Two temperature ranges may then be considered, *i.e.* those above and those below 1650 deg. F.

(a) Furnace temperatures below 1650 deg. F. — Sulphur dioxide in this range causes an important increase in the rate of scale formation in the absence of oxygen. Oxygen itself, while causing rapid scaling, renders sulphur dioxide ineffective. It was found that 0.1 per cent SO_2 in an oxygen-free atmosphere caused the same increase in scaling as 2.0 per cent oxygen. There was no evidence of intercrystalline penetration in plain carbon and 1.5 per cent Mn steels, but with 5 per cent Ni steels 0.05 per cent SO_2 concentrations made slight penetration. With 0.2 per cent SO_2 for 8 hrs. at 1560 deg. F. penetration was 0.002 in., but with 3 per cent oxygen there was none. The 3.5 per cent Ni, 0.75 per cent Cr steel and the 12 per cent Cr steel showed slight evidence of penetration without oxygen. Sulphur dioxide destroyed the oxidation resistance of 4 per cent Si steel, while the 12 per cent Cr and the 8 per cent Al steels showed very slight attack.

(b) Furnace atmospheres above 1650 deg. F. — At higher temperatures SO_2 rapidly increases the rate of scale formation, and penetration of the sulphide-oxide complex into the steel. Penetration was most severe with the 5 per cent Ni steel, extending to 0.02 in. in 1½ hrs. at 2100 deg. F. with 0.2 per cent SO_2 present. The plain carbon, the 13 per cent Mn, and the 3.5 per cent Ni 0.75 per cent Cr steels also showed deep penetration.

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Stubborn, some horses. But intelligent, too!

That's why we say the fellow who really uses the brain he was born with . . . has "horse sense."

We think many of our customers, who know that welding is a *metallurgical problem,* show that kind of judgment by insisting on McKay Shielded-Arc Welding Electrodes. Because the solution to metallurgical problems starts in the laboratory . . . with microscopes and test tubes and painstaking analyses. McKay Electrodes come from the "researched line" . . . the only line, to our knowledge, developed in a great nationally known research institute.

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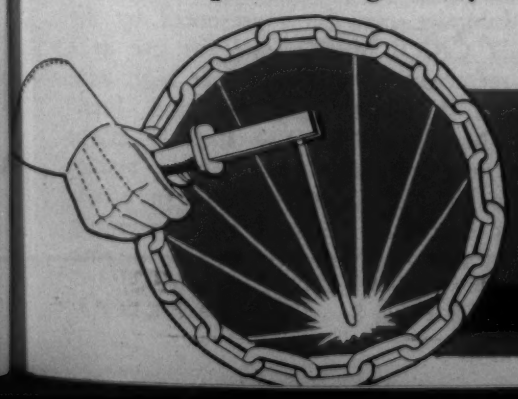

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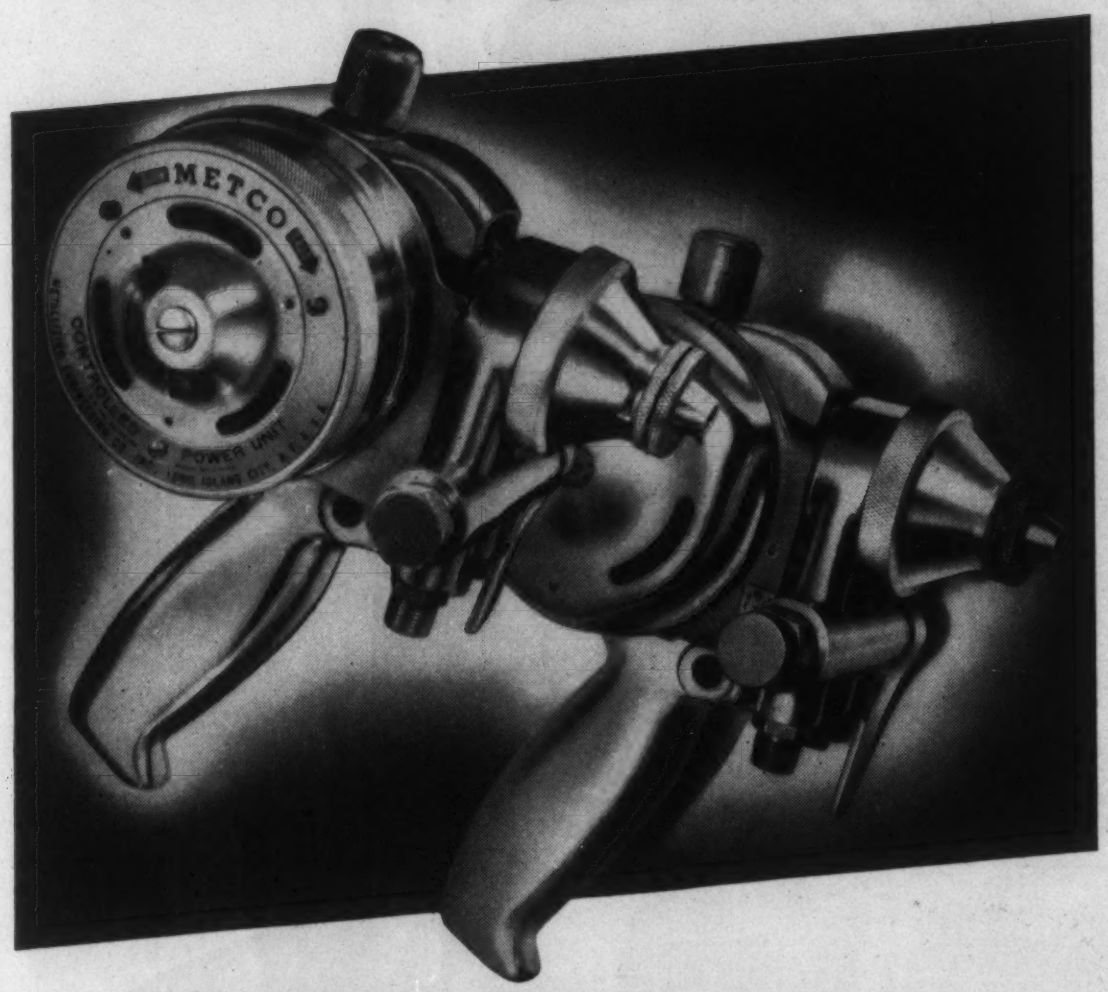

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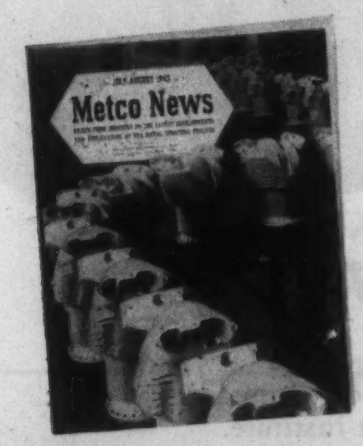

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No penetration was found in the 4 per cent Si, the 3 per cent Si, the 9 per cent, 12 per cent and higher Cr steels. When atmospheres contained less than 0.03 per cent SO_2 no oxide-sulphide complex could be found in the slag, and there would appear to be little advantage in taking sulphur removal beyond the point which gives this concentration.

—A. Preece, *Metallurgia*
June 1943, Vol. 28, pp. 91-93

Iron from the Basic Cupola

Condensed from "Foundry Trade Journal"

The percentage of sulphur in foundry coke ranges from 0.50 to 1.0 per cent, and is present in two forms, namely, sulphide sulphur, *i.e.*, CaS and FeS, and elementary sulphur. In the combustion of coke the FeS and elementary sulphur are oxidized to form volatile sulphur dioxide, part of which may escape with the waste gases, or part may be taken up by the lime present in the charge as follows: $4CaO + 4SO_2 = 3CaSO_4 + CaS$. The calcium sulphate dissociates at temperatures in the region of 2375 deg. F. according to the equation $2CaSO_4 = 2CaO + 2SO_2 + O_2$.

In normal cupola practice, the slag-forming constituents are mainly of an acid nature. Thus, the slag produced with the added flux is of low basicity. By substituting a basic lining for the usual acid refractory, the slag basicity can be increased and the properties of this type of slag are such that it offers the possibility of desulphurization in the furnace.

The results obtained in a series of experimental melts conducted in a basic-lined furnace have given sufficient justification for the deduction to be made that a basic cupola process is a practical proposition, and not only can sulphur pick-up be offset, but under suitable conditions of operation the metal can be desulphurized below the charged composition. While slag basicity is an important factor in desulphurization, certain conditions of furnace operation must exist in order to obtain the maximum effect, and further investigation is required to establish ideal conditions, as also the effect of operating temperatures, slag volume and viscosity.

The basic cupola process has been adopted on a full scale production unit, and the previous practice of desulphurization with soda ash has become unnecessary. The cupola concerned is occupied in melting low carbon metal, which is run directly into an electric furnace. The furnace is being regularly operated to give metal with 50 per cent lower sulphur content than was obtained in the acid furnace.

The cupola has a lining thickness of 12 in., and the internal diameter is 36 in., with a normal melting rate of 9500 lbs. of metal per hr. Stabilized dolomite was used, and special precautions were taken during the ramming to allow for after-expansion which amounts to about 1.50 per cent for this material. The mineral dolomite may be represented by the formula $CaCO_3\ MgCO_3$ and for use as a basic refractory it is calcined at high temperatures to give magnesia and lime: $CaCO_3\ MgCO_3 = MgO + CaO + 2CO_2$.

The magnesia after calcination is stable, but the lime hydrates readily. In recent years a successful method for preventing this hydration has been evolved by mixing

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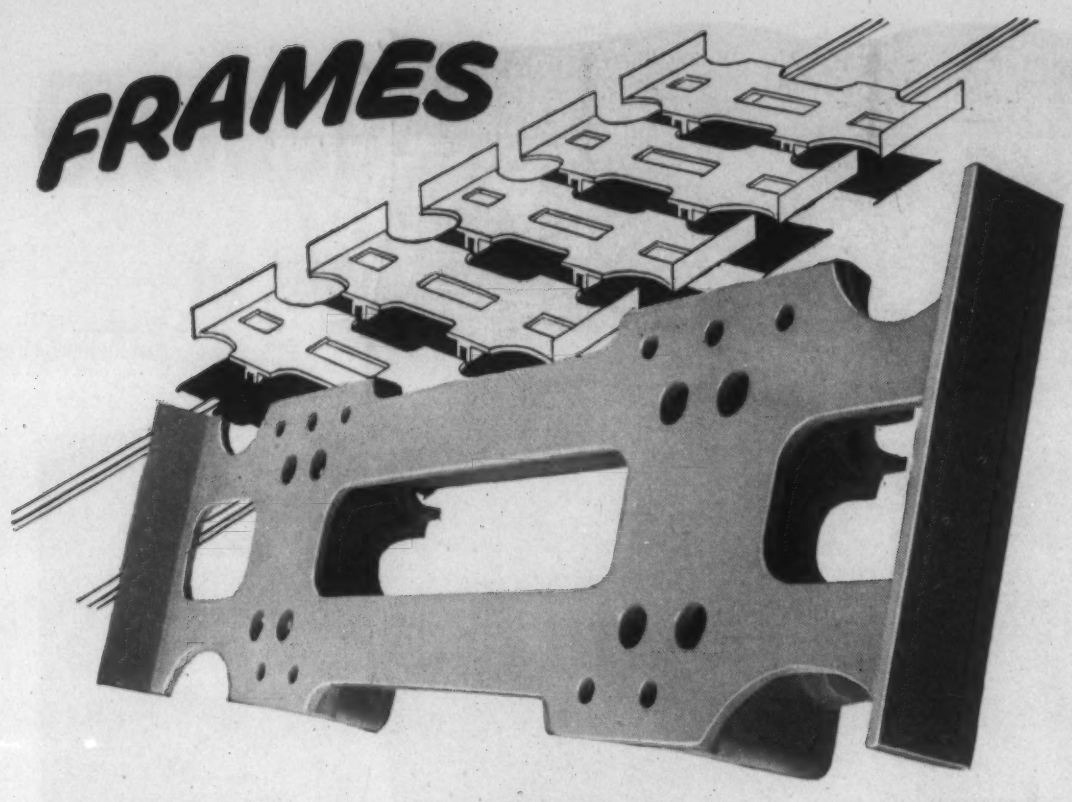

Castings like this form the frames of cars used to convey stainless steel into furnaces.

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6 parts of dolomite with 3 of serpentine: $6(CaCO_3 \cdot MgCO_3) + 3MgO \cdot 2SiO_2 \cdot 2H_2O = 2(3CaO \cdot SiO_2) + 9MgO + 2H_2O + 12CO_2$.

The product, known as stabilized dolomite clinker, is suitably ground and made into brick form or cement suitable for ramming or patching when mixed with water.

—E. S. Renshaw, *Foundry Trade J.* Vol. 70, June 24, 1943, pp. 149-153.

Shotblasting Aero Engine Parts

Condensed from "American Machinist"

The Aircraft Engine Production Committee of the Central Aircraft Council has conducted a cooperative study on shotblasting with two objectives: (1) Elimination of the tedious final polishing formerly deemed essential on connecting rods and other engine components; and (2) attainment of extra fatigue strength by prestressing the surface. Complete or partial success is indicated for connecting rods, rocker arms, master rods, link rods, crankcases, impellers, magnesium housings, valves and valve spring washers. Knuckle pins and similar parts will probably also be shotblasted.

It is asserted that corrosion, corrosion fretting and even grinding notches can go entirely through the shotblasted layer before serious harm is done. Considerable time savings are realized as the final polishing operation is eliminated and the part is shotblasted after a rough polishing (*i.e.* with a 70 or 80 grit wheel). Typical time savings are: 30 hrs. per 12 cylinder engines by shotblasting connecting rods; 12 hrs. per engine by shotblasting rocker arms.

Although there is some question as to the maximum permissible surface roughness before shotblasting, a profilometer reading of 150 micro-inches (80 grit wheel) finds most favor. The finish should be good enough to avoid tool marks showing up after shot blasting. Actual fatigue results have shown up to 30 times the fatigue life for shotblasted engine parts.

The actual conditions of shotblasting are best established by experience. However, some data indicate that the time should range from 5 to 10 sec. for each of four passes over a connecting rod. An empirical method devised by J. O. Almen is used to predict the depth of pre-stressing. A thin metal strip, fastened to a heavy base, is subjected to the same shotblasting as the workpiece. The curvature of the strip after it is removed is an index of the cold working induced by shotblasting. Several sizes of test strips have been developed; one is 0.050 in. thick for testing the shotblasting effect on aluminum, while another is 3/32 in. thick for steel.

Some committee members believe that there are two drawbacks to finishing engine parts by shotblasting: Distortion of thin sections, and the tendency to cover up Magnaflux indications. Parts such as connecting rods tend to grow as much as 0.008 in. in shotblasting, but one producer finish machines the pieces after shotblasting to overcome this. One producer says that the use of red powder in Magnafluxing will show up any important defects after shotblasting. Another says that flaws that cannot be seen after shotblasting are not of the kind that will cause the part to fail. Shotblasting may also prove a means of salvaging parts; four connect-

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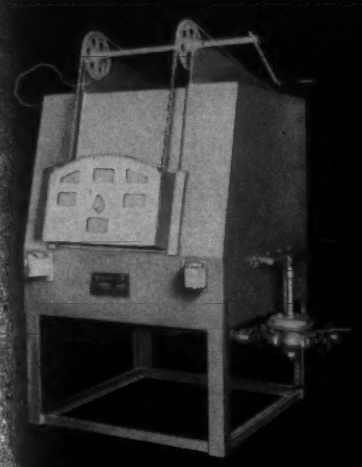

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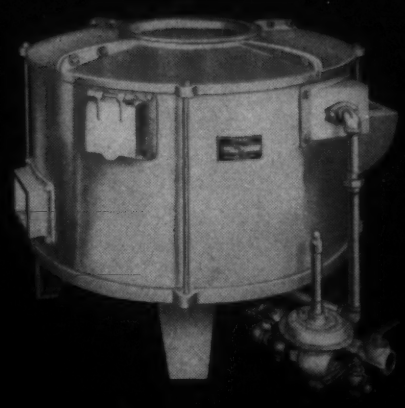
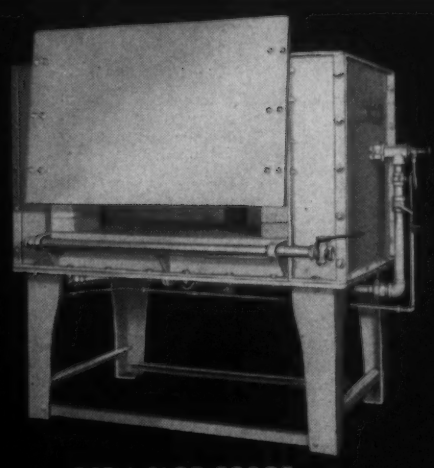
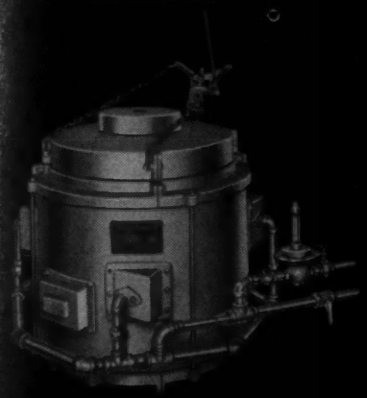


ROUND POT FURNACE



OPEN SLOT FORGE



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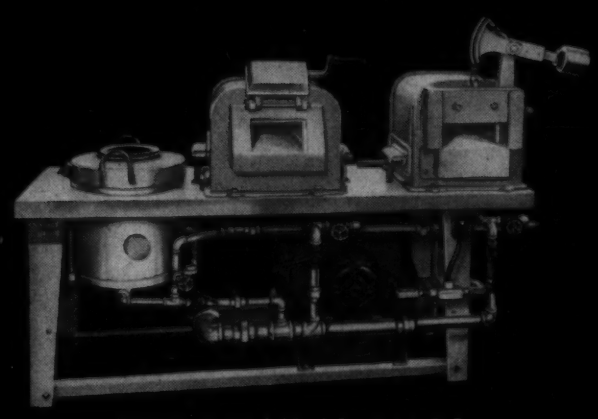
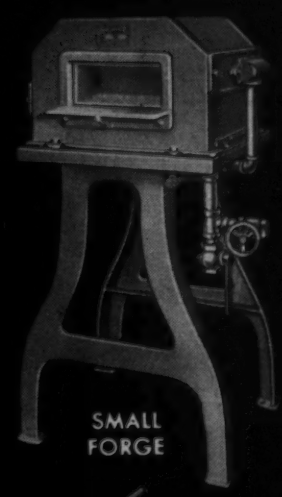
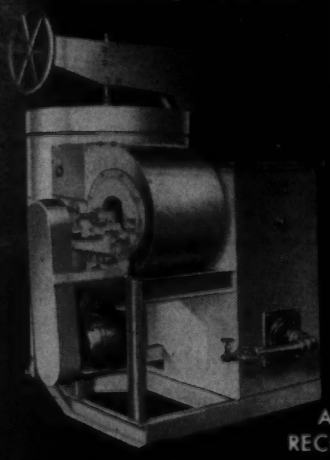


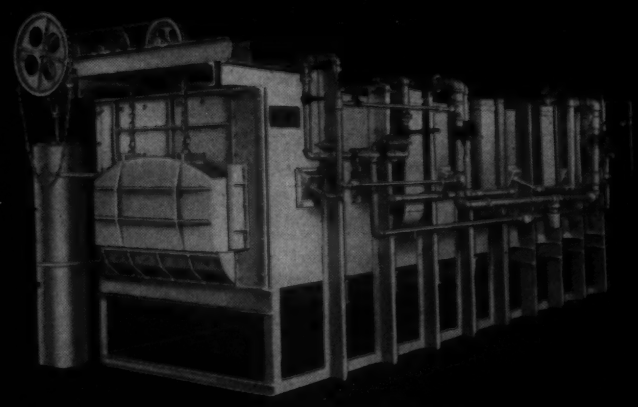
TRIPLE PURPOSE COMBINATION



SMALL FORGE



AIR DRAW RECIRCULATING FURNACE



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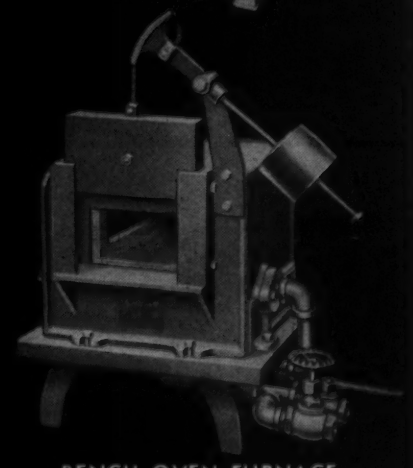

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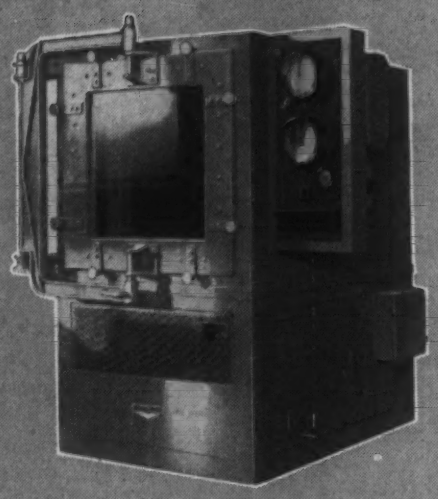

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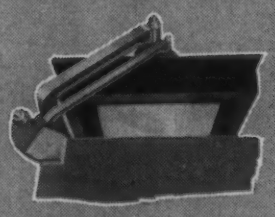

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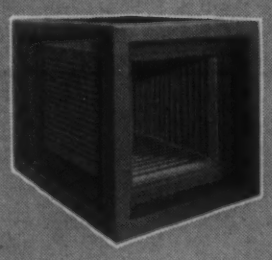

Cold-Liner interior of KOLD-HOLD Stratosphere, showing rugged, heavy-duty construction.

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ing rods were rejected after Magnafluxing, but shotblasting eliminated the indications of the flaws.

Lead plating, rubber plugs and rubber shields have been used to avoid shotblasting effect upon certain sections of the work. Some feel that the junction between the shotblasted and non-treated areas has a deleterious effect. Wire brushing across the demarcation line has been suggested.

—*American Machinist*, Vol. 87, June 24, 1943, pp. 88-89.

Long-Life Cartridge Tools

Condensed from "American Machinist"

The Lake City Ordnance Plant has established an excellent record in prolonging tool life. Certain tools which in the past turned out only 5,000 parts now give runs of 250,000 in the same machines under the same operating conditions. This success is based mainly on careful selection of steels, greater resort to forging, precision heat treatment and extremely fine finish.

Heading, pocketing, bunter and bullet sizing dies were formerly made by machining. However, now all these dies are made by forging because of the vastly superior service obtained with forged dies. The forging refines the grain and "turns it around" so that the grain runs crosswise not longitudinally in the tools. When new steel is used for a tool, a piece of suitable size is cut from a bar and tempered by heating to 1250 deg. F. and air cooling.

The steel is then hammered until the length of the piece is at right angles to the original length of the bar. However, two-thirds of the work in the forge shop is salvage work. For example, new steel is used for 0.50-cal. heading dies; when these dies are worn they are reworked into 0.50-cal. pocketing dies, then into 0.30-cal. heading dies and finally into 0.30-cal. pocketing dies.

The forged steel is annealed by heating to 1650 deg. F., soaking, and permitting to cool for 72 hrs. in a special soaking tub. This tub consists of a small steel drum welded inside an oil drum so as to give about 3 in. of space all around. The space is filled with lime and sealed by welding. As each forged piece is placed in the tube, it is covered with powdered mica. As soon as the tub is filled with work, the lid is clamped on, and the pieces are permitted to cool. In this way, the large annealing furnaces are not tied up for long periods, as would be the case if furnace cooling were used.

After machining, the tools are heat treated. Large tools are heated in Char-Mo furnaces, smaller tools in Houghton's N. D. Liquid Heat to prevent scaling and decarburization. Special racks of heat-resistant steel are used to hold the tools in batches during heat treatment. Except for tools of high-carbon high-chromium steel, most quenching is done in brine. If the inside diameter is the working surface, a brine spout is used to cool the bore, leaving the outside ductile. Tempering is done in electric furnaces or Drawtemp.

The tools are given a mirror finish by polishing before and after heat treatment. The pretreatment polish is especially important, since it removes tool marks that

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Here's a silver alloy brazing flux that simplifies your brazing procedure . . . permits faster work . . . provides better results.

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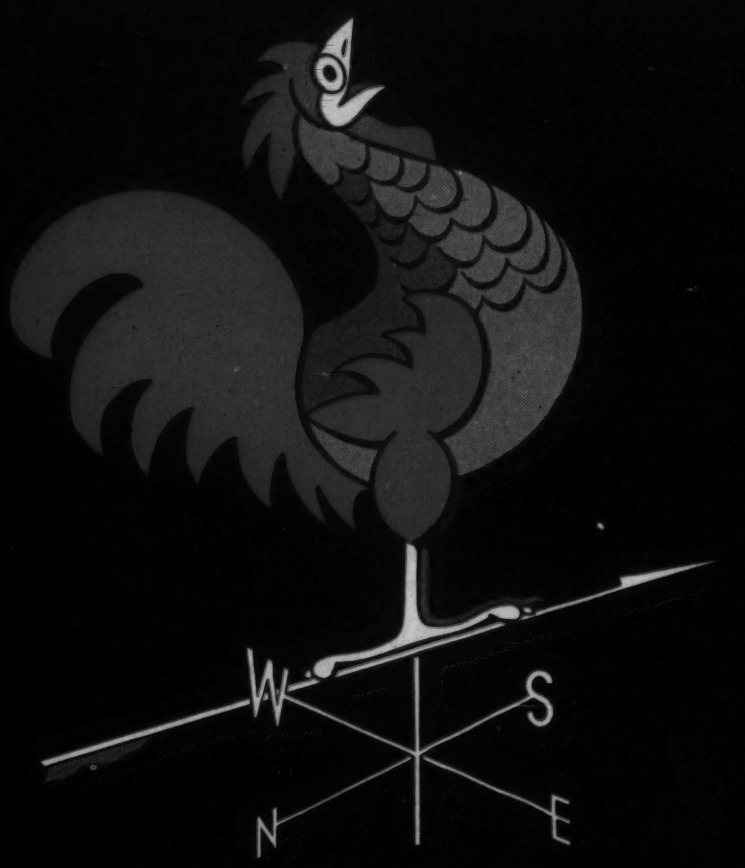

...as a Weathercock to the breeze!

The demands of war in an industrial as well as a military sense, are ever changing. We must be *sensitive* to these changes — always ready to meet them, regardless of the cost in disappointment, upset schedules, temporary confusion, more work where it seemed that the most possible was already being done. We constantly endeavor to make this the keynote of our operations, realizing its necessity in hastening ultimate victory!

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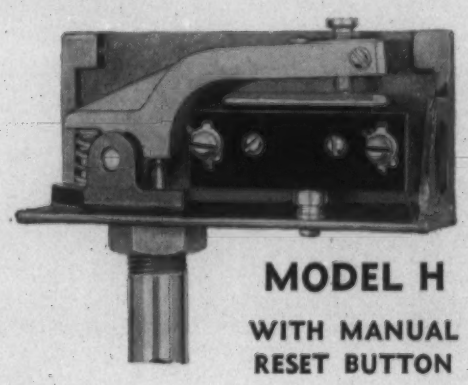

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- **Corrosion and heat resisting tube**
- **Dial Pointer for easy setting**
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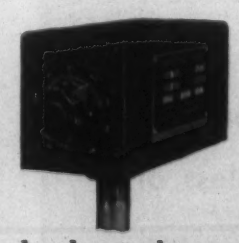
MODEL D



For use where temperatures must be changed to suit operating conditions. Turn outside knob to change temperature setting. Simple in design . . . accurate and dependable under severest operating conditions. Temperature range 0-1400°F. Standard adjustable range 200-500°F. Single snap-action switch. (Dimensions: 5½"x2¾"x2¾")

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would be difficult to get rid of after hardening. For some of the tougher cases, diamond dust and olive oil are applied with cotton batting to give a fine finish in a relatively short time.

In the case of bullet and cartridge case punches, the polishing marks must run with the length of the punch. Chromium plate (which is used for salvage and for tools such as bullet and cartridge case punches and sizing dies subject to severe frictional loads) does not lessen the need for a high finish on the steel.

The heavy duty 0.50- and 0.30-cal. heading and pocketing dies are made of 3.5 W, 1.2 per cent C steel. High carbon tool steel is used for smaller dies and most punches. Dies with thin sections or cupped edges are made from high-carbon high-chromium steel, which can be oil-quenched without fear of quenching cracks.

—*American Machinist*, Vol. 87, July 8, 1943, pp. 109-112.

Metal-Degreasing Agents

Condensed from "Metal Finishing"

The principal methods of industrial metal cleaning are: (1) the use of alkaline compounds which exert a saponifying or emulsifying action on the grease or oil; (2) cleaning with chlorinated hydrocarbon solvents; (3) cleaning with petroleum solvents such as gasoline or naphtha.

Alkaline cleaners contain one or more compounds such as sodium carbonate, caustic soda, trisodium phosphate or sodium silicate. Alkaline cleaning is effective for many metal parts. Some of the shortcomings of alkaline cleaning are said to be the danger of etching precision parts, the danger of staining insufficiently rinsed parts, slowness, and failure to clean inaccessible recesses.

Metal cleaning with chlorinated solvents is one of the most recent cleaning developments. This is perhaps the best cleaning method. The most important solvents used are trichlorethylene, carbon tetrachloride, and perchlorethylene.

The solvent is applied by dipping, spraying or condensation of vapor on the parts, or combinations of these. It is necessary to add a corrosion inhibitor and a stabilizer to trichlorethylene. The stabilizer prevents decomposition induced by certain metals, notably aluminum, magnesium, or zinc, or their alloys.

In the case of carbon tetrachloride, corrosion may be reduced to a minimum by constructing the equipment of selected metals in the following order: nickel, Monel, 18-8 stainless steel containing 2 to 4 per cent molybdenum, lead, tin, well-tinned copper, galvanized iron, and copper.

In cleaning with petroleum solvents, each part is dipped in successive baths. The solvent soon becomes contaminated and the method is relatively slow and inefficient.

Some Comparisons

There is no fire hazard with alkaline cleaners. The chlorinated solvents are non-inflammable, although trichlorethylene-air mixtures are flammable under certain conditions. Petroleum solvents are highly flammable and explosive. Following is the order of the fire risk of some petroleum solvents, with the most hazardous

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Solvent, and F-140. Carbon tetrachloride is often added to petroleum solvents to raise the flash point and reduce the fire hazard, but the flash point range of the solvent itself and the loss of carbon tetrachloride by evaporation during use makes this an unsafe practice unless carefully controlled.

No cleaners are entirely without health hazards. Alkali cleaners will cause serious burns. Operators should be equipped with goggles, rubber gloves, boots, and aprons. Chlorinated solvent vapors are toxic. Since the vapors are heavy, rooms should be ventilated with exhaust ducts placed at the floor level. Petroleum solvents are less toxic than chlorinated solvents. The order of toxicity is: naphtha, gasoline, Stoddard's Solvent, and F-140.

Relative costs of the different methods which would apply to any user cannot be stated. The cost of supplies is least for alkaline cleaners. In the case of chlorinated solvents, the liquid is used over and over, so that a higher original materials cost may not represent a higher operating cost.

—H. P. Quadland, *Metal Finishing*, Vol. 41, 1943, pp. 463-465.

Welding of Tank Armor

Condensed from "Welding Journal"

The arc welding process has opened an entirely new field of manufacturing, that of welded tanks. The methods that have been developed can be used on every type of welded fabrication, in many cases to a big advantage on present work, and to a tremendous advantage on future fabricating work. Most important is that through welding it is possible to manufacture tanks in large volumes and not to be dependent on so many machine tools or on inadequate steel foundry capacity.

Welding eliminates hundreds of pounds of butt straps. This means less weight per horsepower and an increase in performance. The welding process saves a large amount of machine tools due to flame-cut edges and absence of drilled holes.

Early Trials

Welding operations were started with different ferritic welding rods. These ended in complete failure due to the high hardenability of the high-alloy armor plate, and because there was no preheat and postheat or anneal. Failure was due to excessive cracking at the fusion zone. Under shock firing, such plates fell apart with the first shot.

Next, tests were made with an austenitic electrode. This rod was more successful, and sound welds were made which passed Aberdeen Proving Ground tests. Using the above rods, however, caused a series of troubles such as root bead cracking, and excessive grinding and chipping was required.

Welding electrode manufacturers started to develop a lower-alloy rod for welding high-alloy armor plate of high hardenability. Better results were obtained. There was less cracking in fusion zones and less cracking in weld metal.

The material also had better ballistics for weld deposits. The deciding test is the shock test developed by Aberdeen Proving Ground. The shell did not penetrate the weldment but was used to give the weld

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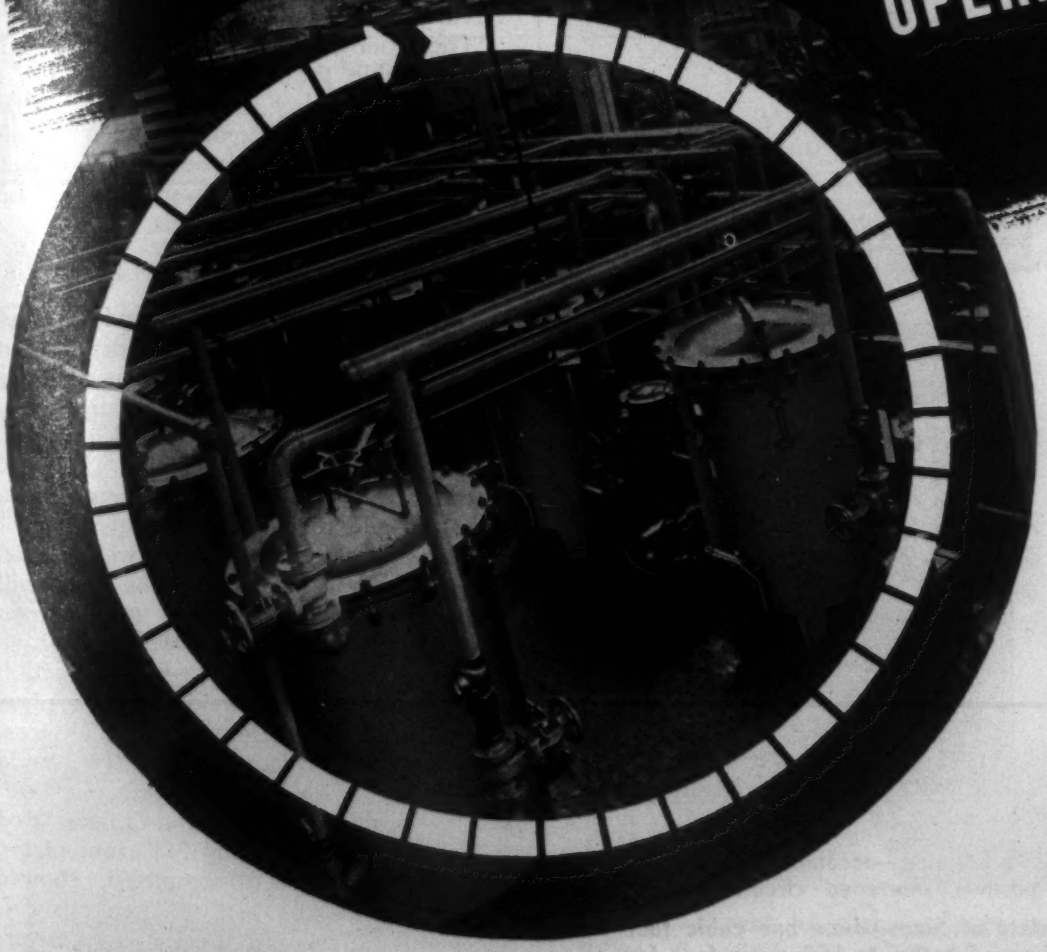

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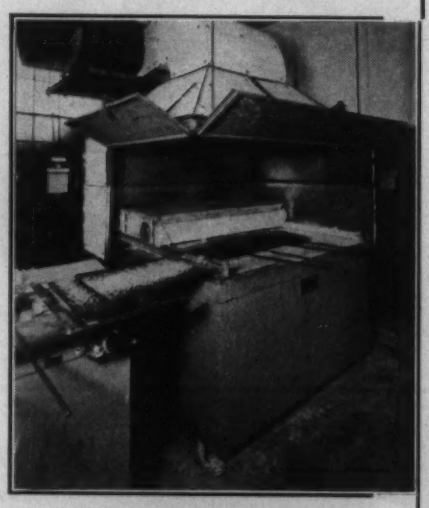

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a very severe shock.

The outcome was that besides saving alloys, a better rod was found for manufacturing tanks. An actual saving of approximately 33 per cent was made in the cost of welding electrode and in the use of chrome nickel alloys.

Welding Technique

Present everyday welding procedures were found inadequate in manufacturing tanks. There are very few fabrications in low carbon steel or otherwise that must stand inspection shock test of a 75-mm. shell fire point blank or that must be held to such close tolerances in building. This meant a new development of plate edge preparation to keep warping to a minimum.

All plate edge preparation is done by the flame-cutting method. This means flame cutting must be held to much closer tolerances. No edge for welding should be done otherwise because of the savings possible. If edges are machined, it means tying up machine tools and labor, and takes a lot more plant space.

It is almost impossible to estimate this saving in dollars and cents, but it is tremendous. It has now been proved that a flame-cut edge can be held within the limits necessary for tank buildings.

The single V of 15, 20, 30 or 40 deg. has been in use as a standard plate edge preparation for normal welding fabrication. This preparation, however, has not been successful for welded tank manufacturing.

The double V was then adapted. It takes double the edge preparation that a single V takes, but it was found to be the answer for weld strength and the only possible way to hold tolerances throughout tank manufacturing on a production basis without using machine tools.

Armor Plate and Rod

Later, it was necessary to find what armor plate was the best for welding. Four types were agreed on. After receiving 16 plates, four from each source, they were all prepared the same 45 deg. included bevel with a root opening. All 16 plates were welded with the same welder, same rod and the same technique.

After these tests, the most weldable armor plate was selected. The tests will also help the armor plate manufacturer to make better plates for welding.

It was then decided to find out which rod was the best for welding armor plate. Again, 16 plates were taken, but all from one source, and it was decided to weld them as follows: Rod manufacture "A" four plates, Rod "B" four plates, Rod "C" four plates, and Rod "D" four plates.

These tests, when completed, showed which rod was the best. When this evidence was gained, all the rod manufacturers were informed and they changed their coatings accordingly. All are supplying satisfactory rods now.

After quality is determined, equalizing stresses is the biggest factor in welding tanks. It means you can make up subassemblies and know they will fit into the following fixture and assembly quickly.

Also, when the tank is completely welded, it will stay in good condition longer.

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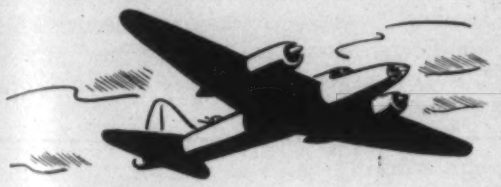
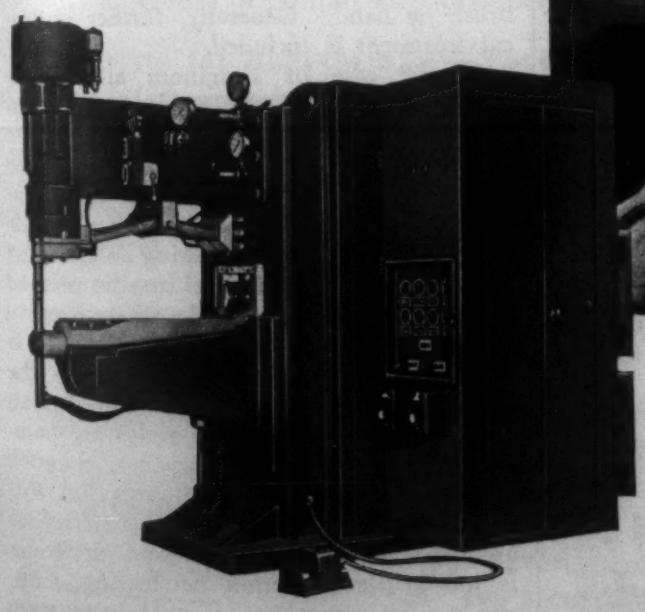


Faced with a severe shortage of extruded parts which threatened the production of Marauder bombers. Martin tool engineers found the answer in the *spotwelding* of heavy aluminum stampings. Parts such as tank door ribs, wing ribs, spars, longerons and fuselage formers are now built up from sheet metal parts in gauges hitherto thought impossible to spotweld.

The huge machine doing this job, has been designed and developed by Sciaky to weld up to two thicknesses of .187" aluminum. Features which have proved so successful in the welding of lighter gauges are employed. The tremendous power required (a flow of 100,000 amperes) is compensated for by the use of STORED ENERGY, which delivers instantaneous welding current without disturbing the plant's power system. Precise control of pressure is accomplished by the Sciaky patented VARIABLE PRESSURE CYCLE which regulates pressures up to 12,000 lbs. in an automatic sequence.

While this machine is being operated twenty hours per day on production, experiments are being conducted to prove its adaptability to steel armor plate, as well as other heavy aluminum parts.



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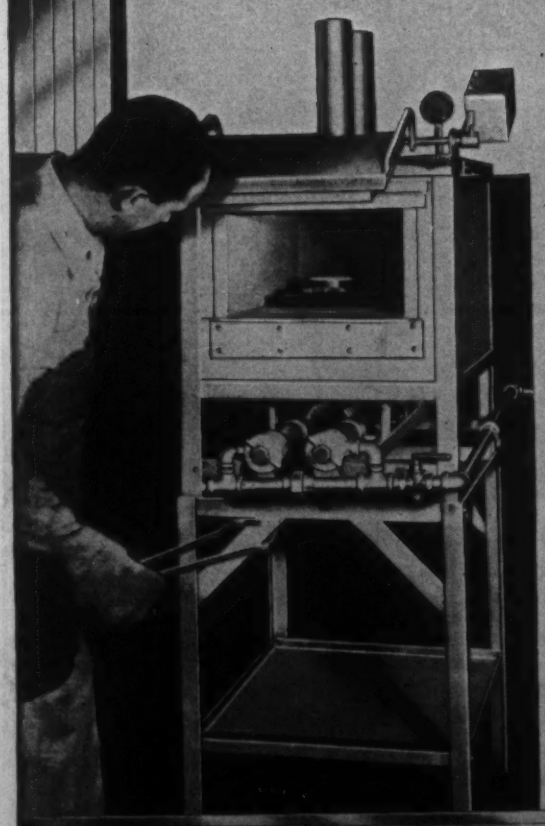

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If the welding stresses are not equalized, undue work or shock stress at some point that is already stressed to its maximum will fail. The welds break or twist to favor the stress.

If sub-assembly methods are used, it will be possible to build many more tanks, due to the fact that parts can be welded any place and final assembly involves only a few big fixtures, instead of having all final assembly fixtures. This is a very vital necessity in saving time, fixture expense, floor space and machine tools.

—E. G. Biederman. *Welding J.*, Vol. 22, July 1943, pp. 516-519

Weld Finishing

Condensed from "Sheet Metal Industries"

The term "weld finishing" includes all operations subsequent to the deposition and solidification of the weld metal, *i.e.* slag removal, stress relieving, electroplating, anodic oxidation or painting, and preparation for inspection. The scope was limited to fusion welding.

The slag must be removed to (1) permit working without forcing particles of slag into the surface; (2) allow inspection; and (3) prevent corrosion. In the case of steels, copper, copper alloys, nickel, and nickel alloys, the slag is generally removed by chipping by hand or pneumatic hammer. Brushing with a hand or revolving mechanical brush of bristle or wire is a common method of slag removal.

Washing, very often combined with some form of chemical treatment, is an important method; it is necessary for light metals, sometimes for stainless steel, and possibly for certain copper alloys. Special or combination procedures may be required for particular jobs. Improper cleaning causes more difficulty in the case of light metal welds than is experienced with other metals, as the flux used in welding is both corrosive and hygroscopic. The only effective way to remove this flux is by washing in hot water.

Three precautions should be taken: (1) Washing must be done within 20 min. of the completion of welding; (2) the work should be soaked for at least 20 min. in water as near to the boiling temperature as possible; (3) the articles should then be scrubbed with a bristle brush by hand. Generally, further chemical treatment is included.

In the case of aluminum alloys, the article is immersed for about 30 min. in a cold 5 per cent HNO_3 solution, then again washed. Magnesium alloys must be given an appropriate chromate treatment immediately after washing. Other metals usually do not require washing or chemical treatment, but stainless steel may be washed in HNO_3 if traces of oxide are present.

The next operation to be considered is cold or hot working to improve the mechanical properties of the weld deposit and to relieve stress. Steel welds are hammered to improve the structure, toughen the weld metal and relieve stress, but this is possible only when coated electrodes are used, as the deposit of bare electrodes is too brittle to permit hammering. Copper can be either hot or cold hammered. Tough pitch or high conductivity oxygen-bearing copper must be hot hammered be-

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fore the weld cools down. Hot hammering is not necessary on deoxidized copper, although it is desirable on heavy material.

Copper Welds

Regardless of whether or not hot hammering is used, copper welds should always be finished by cold hammering and subsequent annealing to improve strength and elongation. Copper alloy welds are not usually hammered. Aluminum and aluminum alloy welds are normally hammered cold after the flux residues have been removed (heat-treated aluminum alloys are not usually fusion welded; if they are, the hammering should be done at a temperature of 400 to 420 deg. C. or 750 to 785 deg. F.). Magnesium alloys are generally not hot hammered and must not be severely cold worked.

A full heat treatment may be required in the case of some steels or light alloys. However, only a stress relief treatment at 400 to 600 deg. C. (750 to 1110 deg. F.) is required for ordinary steel welds.

Smooth surfaces are demanded, usually to improve the appearance but sometimes to reduce risk of corrosion. These surfaces may be obtained by hammering, chipping, grinding, shaving or planing. One of the aims of proper finishing is to facilitate inspection. If the weld is properly finished, the inspector can detect cracks, remnants of craters, serious lack of reinforcement, etc.

Final Finish

The effectiveness of the final finish depends on the efficiency of the finishing operations. Anodic oxidation causes some difficulty because it tends to reveal the structure of the weld deposit. In cases where sandblasting or shotblasting of the whole job is specified, the weld must be properly finished before blasting as otherwise it will show up on the finished job.

—E. G. West, *Sheet Metal Inds.*, Vol. 17, July 1943, pp. 1242-1250; Vol. 18, Aug. 1943, pp. 1433-1436.

Finishing Stainless Steel

Condensed from "Metal Finishing"

The corrosion resistance of stainless steel depends in part on careful and proper finishing treatments. It is therefore important that foremen in charge of the finishing of stainless steel understand the correct procedures.

Stainless steels may be coated with a heavy oxide scale. The removal of this scale is the first operation required in the finishing of stainless steel articles. Prior to pickling, all oil and grease is removed by any suitable degreasing method.

Descaling Solutions

For loosening heavy scale on 18 and 8 stainless steel, the following solution is satisfactory: Sulphuric acid, 10 parts (by volume); hydrochloric acid, 5 parts; water, 85 parts; temperature, 150 deg. F.; time of immersion, 10 to 15 min.

For loosening heavy oxide on 17 and 12 per cent Cr steels the following solution is good: Sulphuric acid, 10 parts (by volume); water, 90 parts; salt, ¼ lb. per gal.; temperature, 160 deg. F.; time of immersion, 10-15 min.

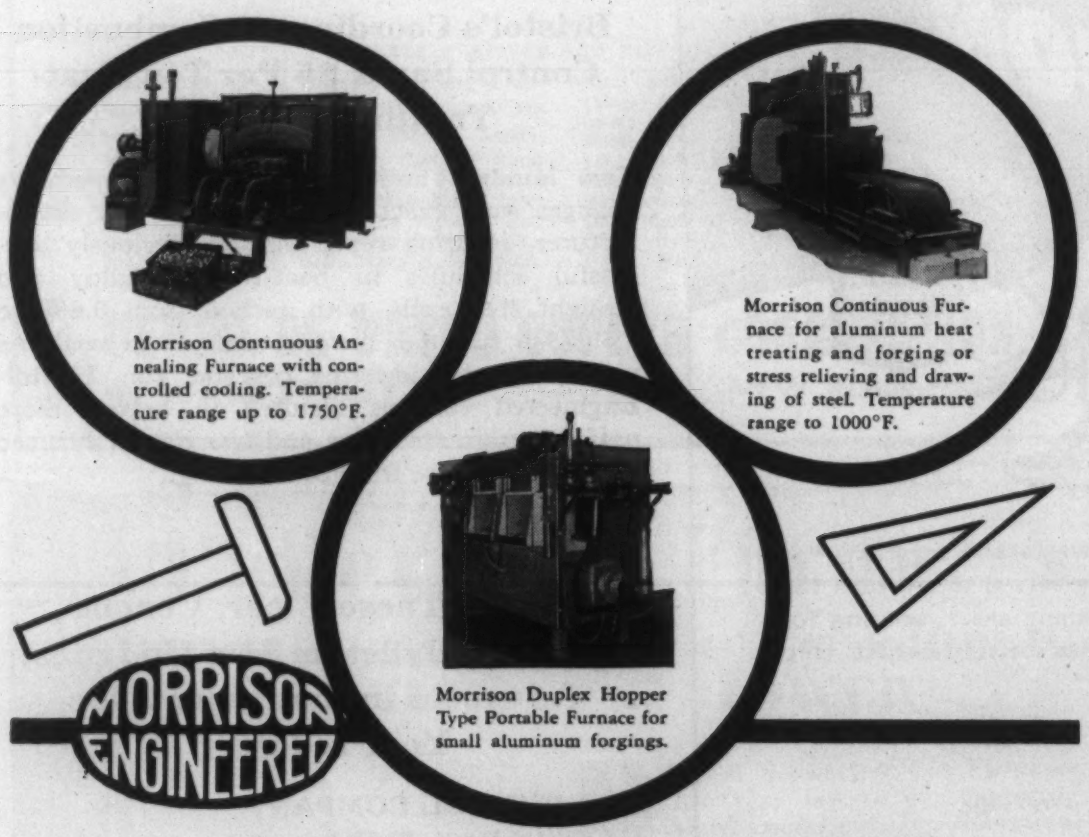
Scale loosened by the above treatments, or light oxides such as are formed by hardening in a controlled atmosphere, may be removed by immersing in the following solution: Hydrochloric acid, 25 per cent (by volume); water, 75 per cent; nitric acid, ¼ lb. per gal.; temperature, 150 deg. F.; time of immersion, 3 to 5 min. A semi-lustrous finish is produced.

All of the above solutions will eventually attack stainless steel. Therefore, a daily addition of a good commercial inhibitor should be made. Acid proof tanks should be used and adequate ventilation provided.

Polishing and Buffing

The next operation after descaling is polishing and buffing. Aluminum oxide is the best abrasive to employ on the polishing wheels. Emery should not be used since it contains iron oxide. If iron oxide particles become embedded in the pores of chromium steels, rusting or discoloration may result. Wheel speeds of 7,000 to 9,000 surface ft. per min. are suitable.

After polishing, the steel should be passivated by dipping in a 20 per cent by volume solution of nitric acid at a temperature of 140 deg. F. This treatment dissolves surface impurities and aids in the formation of the protective film of chromate oxide to which stainless steel owes its corrosion resistant properties.



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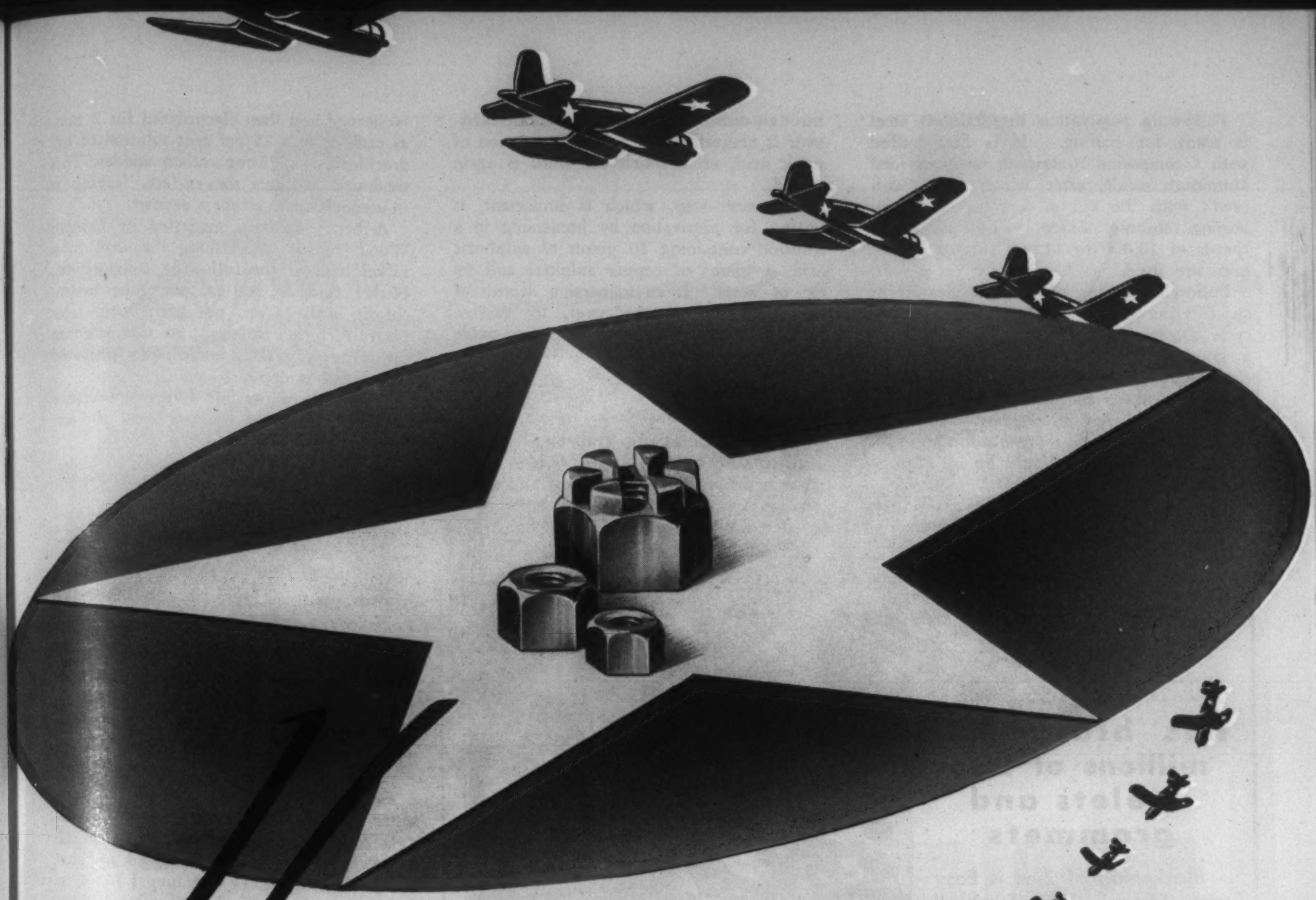

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A New England manufacturer of parts for aircraft had a real problem in getting nuts free of oil and chips. The washing machine in use was of the rotary type with scoop action. A solvent cleaner was being used but it did not get the nut threads clean of very small chips. When the Penn Salt technician called, the manufacturer was trying another type of cleaner in connection with the solvent, but it showed no improvement.

The first Pennsalt product recommended did a thorough cleaning job, removing both the oil and the chips. After a long period of continuous operation, cleaning results were still excellent and a comparison of costs showed a saving of 50% in favor of the Pennsalt cleaner.

It is possible that one of this famous family of cleaners can do as well—or better—for you. Our technical representatives will be glad to cooperate with you on any cleaning problem which you may have. No obligation whatever—and you will get the benefit of experience that covers the entire cleaning field. Write fully to Dept. MA.

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Following passivation the stainless steel is ready for buffing. It is first buffed with a compound containing finely divided aluminum oxide, after which it is "colored" with the aid of a compound containing chromic oxide. Buffing wheel speeds of 10,000 to 11,000 surface ft. per min. are used.

Following buffing the steel is cleaned in an alkaline cleaner. The recommended cycle consists of a 15- to 30-min. soak in a good commercial cleaner followed by electrolytic cleaning. A few "shots" of direct current up to 200 amps. per sq. ft., followed by a few short shots of reverse current, will tend to remove adhering particles. The "shots" should be of 2 to 3 sec. duration.

The shortened time helps to minimize discoloration of the steel. Following through rinsing in water, any alkali carry-over is neutralized with a weak solution of nitric acid, after which the work is again rinsed.

The next step, which is important, is testing for passivation by immersing in a solution containing 10 grams of sulphuric acid, 4 grams of copper sulphate and 99 c.c. of water. If an immersion deposit of copper forms on the steel, its surface is still contaminated with iron oxide which must be removed.

Electroplating

Two procedures are available for electroplating on stainless steel. This is sometimes necessary, *e.g.* when brass and stainless steel are coupled and the brass must be plated. In the first method the article is cleaned and then electrolyzed for 2 min. as cathode in a 25 per cent solution of hydrochloric acid, using carbon anodes. This treatment activates the surface, leaving it in a condition to accept a deposit.

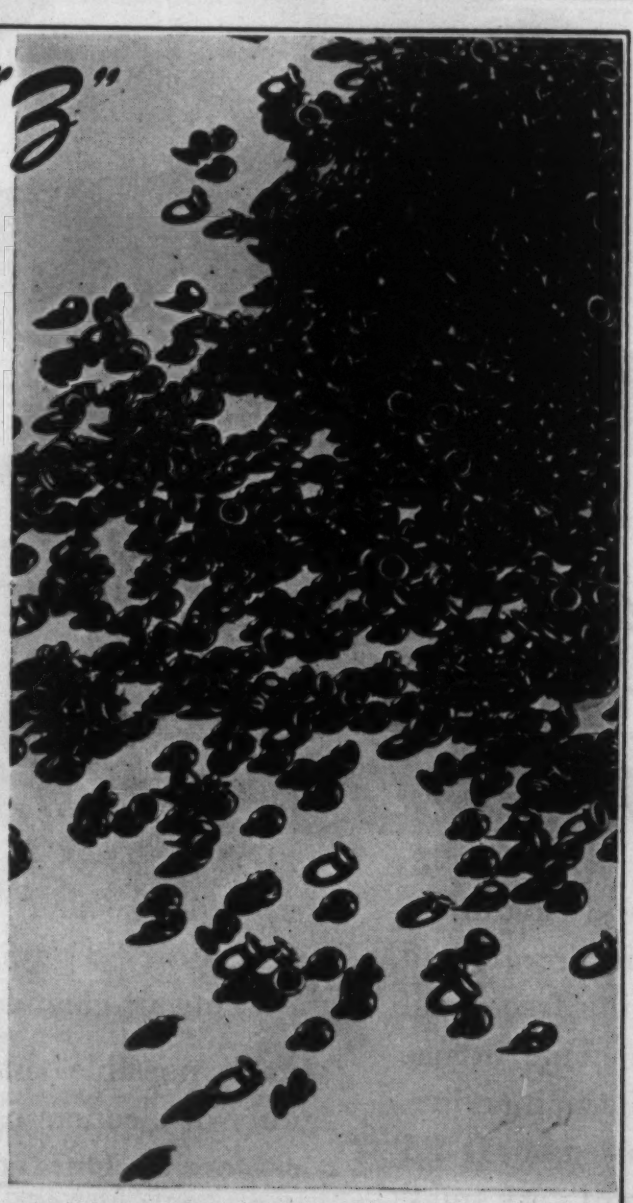
A better method, suggested by Donald Wood, consists in flashing the steel in a nickel bath of the following composition: Nickel chloride, 32 oz. per gal.; hydrochloric acid, 16 oz. per gal.; room temperature, nickel anodes. In this solution the stainless steel is immediately activated and nickel is deposited on it.

A process of possible future importance in the finishing of stainless steel is electropolishing.

—Stephen J. Olphie, *Metal Finishing*, Vol. 41, May 1943, pp. 266-267.

Ebonol "Z"

has blackened millions of zinc eyelets and grommets



Blackening of Zinc is Easy with Ebonol "Z". Tumbled about for 3 minutes in an 8 oz./gal. solution of Ebonol "Z" salts, zinc eyelets are given a beautiful adherent black coating of molybdenum sesquioxide.

Ebonol "Z" can be applied to sheet zinc, zinc alloys, hot-galvanized and electroplated zinc. It removes very little zinc (about 0.00002") and costs about ½c per square foot for materials.

Any metal can be blackened by zinc plating and blackening with Ebonol "Z".

Ebonol "Z" is an ideal method of preparing zinc surfaces for enameling and lacquering.

OTHER BLACKENING PROCESSES

Ebonol "S"—A one bath process for blackening steel and cast iron.
Ebonol "C"—A low temperature process for blackening copper and its alloys.
Ebonol "A"—A process for blackening aluminum and preparing it for plating.

Literature and technical data available on all processes.

THE ENTHONE CO.
442 ELM STREET NEW HAVEN 2, CONNECTICUT

Annealing Steel Cartridge Cases

Condensed from "Industrial Heating"

Steel cartridge cases in sizes from 37 to 105 mm. are given a mouth-end annealing in an automatic machine using radiant gas heat. Since the flame does not impinge directly on the case, discoloration is reduced to a minimum, while scaling is prevented because the work is surrounded by combustion products in all hot zones.

Ceramic cups let down over lines of cartridge cases moving in refractory-lined tunnels containing gas burners, staggered 12 on each side, while a corrugated asbestos heat baffle just below the tunnel helps to localize the heat. Each case rotates about 15 times on an individual spindle, thus achieving uniform preheating, heating, and cooling.

In a 90-in. tunnel, 18 in. are used for preheating, 36 in. for full firing, and 36 in. for confined cooling. At a 3-in. center-to-center distance between spindles 36 cases are in the tunnel at any instant. One cartridge case is annealed every 2 seconds.

The annealing tunnel is removable by lifting, is adjustable in position to allow for expansion, and is lined with 4½ in. of insulating refractory. The conveyor is adjustable for speed, and each burner has an independent needle-valve adjustment to permit any heat distribution pattern desired. The machine is hand loaded, at 36 in. above floor level.

—*Industrial Heating*, Vol. 10, August 1943, pp. 1126-1128.

Coal-Fired Forging Furnaces

Condensed from "Industrial Heating"

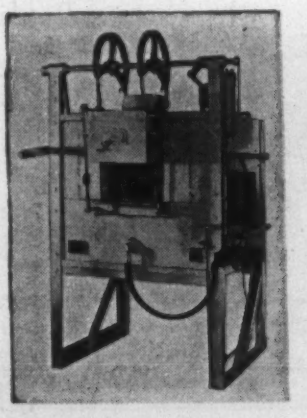
While heating with coal, burning on a grate, is considered obsolete in the United States, it is used today in one region of North America where oil is scarce and expensive, and natural gas not available. Billets for forging and rolling are heated to a very uniform temperature in this furnace, 750 billets being stored at one time. The billets are less than 4 in. across flats, and are heated for about 4 hrs., more than 60 mins. per in.

The grate is 6 ft. long, the hearth 49 ft. long. The ashpit is closed, and air is blown into it by a fan blower. Steam is blown into the pit to prevent clinkering, and to keep the roof over the grate from burning out. Coal with 37 per cent vola-

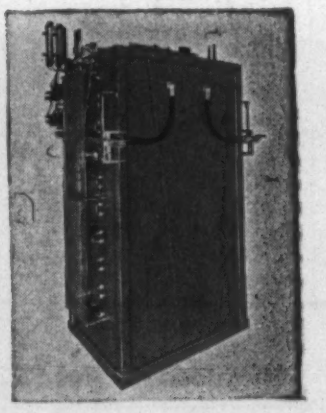
Backing Him Up!

ELECTRIC CERTAIN CURTAIN FURNACES

Compared with the heat treatment of the 1920's it is safe to say that high speed steel working qualities are today developed so that the same type of tool does three or four times the work—saving time, man-power, steel and dollars. Biggest factor in the change is effective furnace atmosphere control—as pioneered and typified by "Certain Curtain." Not only has it led to the maximum development of steel life, but in addition Hayes-hardening has brought heat-treating to the pitch of machine-gun speed and rifle accuracy. Hardening production per man per furnace has increased 50% or more, while spoilage formerly due to atmospheric attacks has been eliminated.



Standard Furnace for hardening high speed steel tools.



Special vertical furnaces for hardening large broaches up to 7 feet.

Sintering Metal Powders

In the field of powder metallurgy, "Certain Curtain" control is proving of tremendous value. Ask about our special furnaces designed expressly for this purpose.

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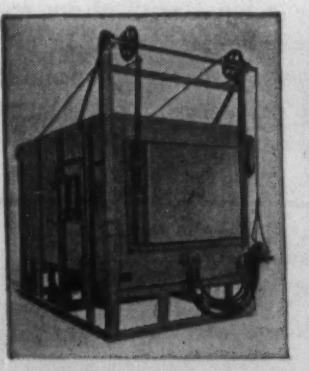
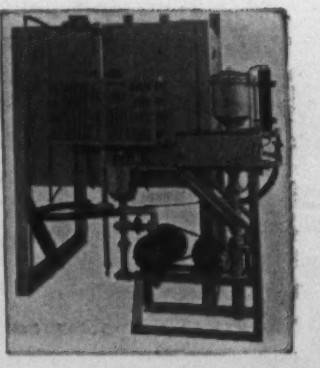


Special furnace for hardening large dies.



Special furnace for hardening MOLY STEELS without decarburization.

World's Leading Controlled-Atmosphere Furnace

tile matter was fired in one installation, giving a bright luminous flame, which changed to dull red, then to black smoke at the cold end of the furnace.

Admission of secondary air at half furnace length failed to burn the smoke, and an oil burner was finally installed at each side of the furnace near the cold end. This burned most of the smoke, and made the billet charging end hot.

Automatically maintained temperature is impossible with coal burning on a grate, but the attendant controlled by means of a recording pyrometer. The indicated temperature was about 1900 deg. F.

The furnaces are 7 ft. wide inside, and 210 forgings per hr. are made from 48.5-lb. slugs, with a coal consumption of 2.6 gross tons of coal for each 8-hr. shift, plus 16 hrs. banking.

—W. T. McGhee. *Ind. Heating*, Vol. 10, Aug. 1943, pp. 1166, 1170.

Low-Temperature Treatment for Aluminum and its Alloys

Condensed from "Aluminium"

Experiments were made to find a treatment which produces in thin light metal strip the optimum of mechanical properties. The semihard sheets at present mostly used vary too much in quality.

In place of them, it is suggested that a "tempered" material, produced by heat treatment at low temperature be used. For example, at 400 to 500 deg. F., a lowering of the mechanical properties without recrystallization takes place; at 535 to 610 deg. F. of mechanical properties and partial recrystallization occur; and at 660 to 750 deg. F., the beginning and partial completion of recrystallization take place.

The resistance of strip treated in this way against organic and inorganic corrosive agents was tested exhaustively, and the following general conclusions drawn. In all tests it was evident that in the "tempered" condition the corrosion resistance decreases for pure aluminum and aluminum-manganese; the lower the tempering temperature the more pronounced is the decrease. Distinct differences between the materials were found in the "tempered" state, depending on the acidity or alkalinity of the corroding agent.

While aluminum-manganese alloy is inferior to pure aluminum in an acid medium, its corrosion resistance increases as compared with pure aluminum in oxidizing and/or alkaline media. The practical conditions of service will have to decide which material is the best for a given case —*i.e.* whether the mechanical or corrosion behavior is the determining factor.

—H. Wolf, H. Tuxhorn & H. Neunzig. *Aluminium*, Vol. 24, Oct. 1942, pp. 341-347.

Grinding Tungsten-Carbide Tools

Condensed from "Edgar Allen News"

The outer rim or periphery of a cup grinding wheel must never be used for carbide tools as it produces a certain amount of concavity which is harmful to efficiency. The grinding wheel should rotate in the direction of the tool, moving it slowly across its face with an amount of pressure less than used for a high-speed steel tool to avoid cracks by heating.

Wet grinding is recommended, but if dry grinding is necessary, the wheels should be kept open and true to shape. The tool must not be cooled suddenly with water if it has become too hot. Vibration and chatter must be eliminated from the grinding operation.

Diamond lapping for giving a final edge to the tool is recommended as it increases the serviceable life of the tool. Diamond grinding wheels should not be used for rough grinding as they remove material rapidly.

—*Edgar Allen News*, Vol. 21, Mar. 1943, pp. 115-116.

Convected Air Furnaces for Aluminum

Condensed from "Aluminium"

A comparison was made from the operating point of view between a salt bath furnace of 5½ cu. m. and an air-circulating furnace of 7½ cu. m. capacity, the former with a quenching bath, the latter with a water-spray chamber for quenching. The higher investment and energy consumption of the air furnace are balanced by the cost of salt in the bath furnace.

The low heat storage of the air furnace gives it greater flexibility for use with different materials and at different temperatures, while the high heat content of the salt bath furnace is advantageous for

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SAVE IT WITH
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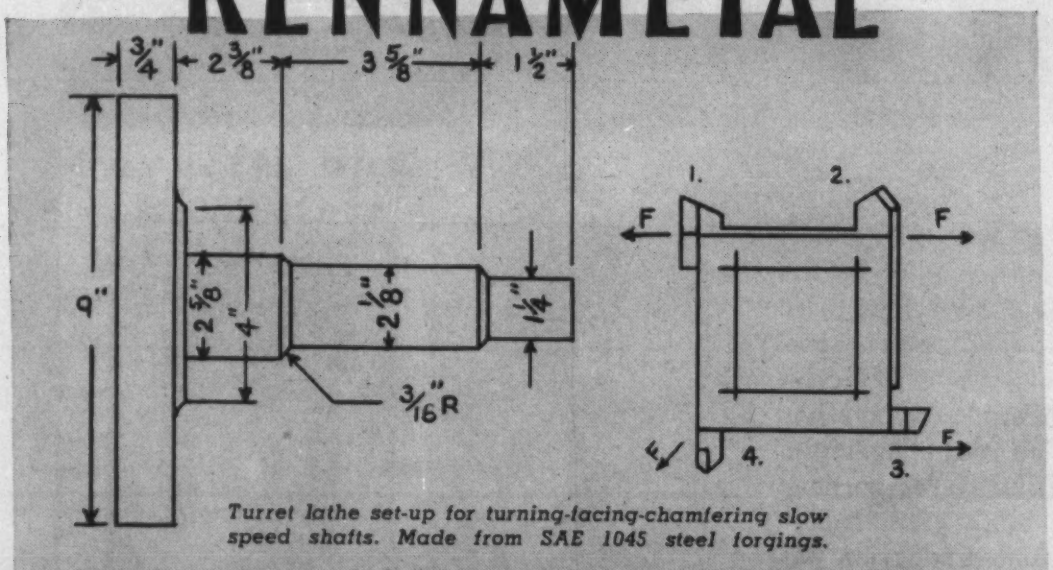


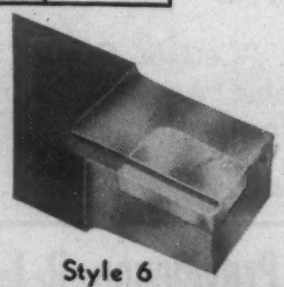
Turret lathe set-up for turning-facing-chamfering slow speed shafts. Made from SAE 1045 steel forgings.

OPERATION	TOOL	GRADE	FEED	DEPTH	R.P.M.
TURN	1) 10T80	KM	.021	1/8" to 1/2"	350
FACE	2) 12T80	KM	.021	1/8"	133
CHAMFER	3) 15T50	KM	HAND	——	350
RADIUS	4) 6T50	KM	HAND	——	350

★Today, as in no other period in the history of our country, time is a precious asset that must be preserved. In order to overtake the enemies' war production, our only recourse has been to adopt methods that will save time. KENNAMETAL is a distinctive time-saving development.

With KENNAMETAL'S high wear-resistance, greater strength and hardness, many machine jobs can be done more rapidly. In this turning-facing-chamfering operation on slow speed shafts, KENNAMETAL did the job in ½ hour as compared to 1¼ hours for competing carbides, and 2½ hours for high speed steel.

KENNAMETAL tools, properly chosen, will step up your output also. Write for your copy of the valuable KENNAMETAL Tool Manual. It will help you select the correct KENNAMETAL tool for your steel-cutting operations.



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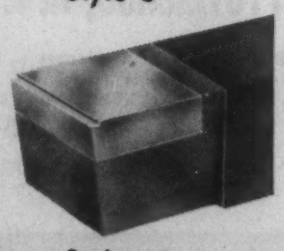

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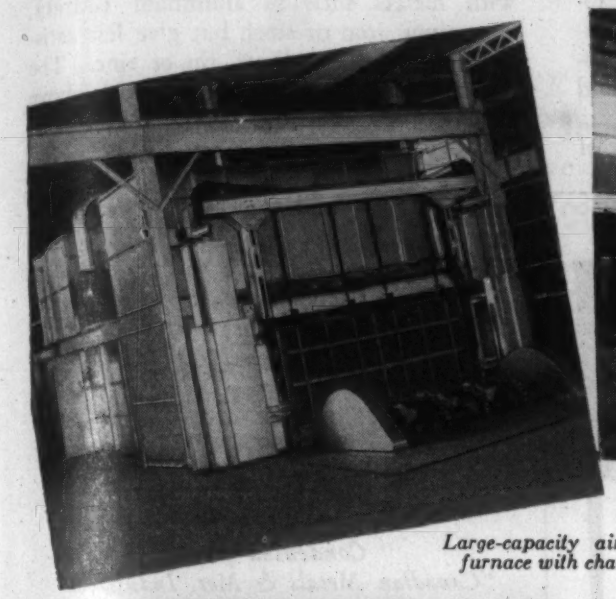
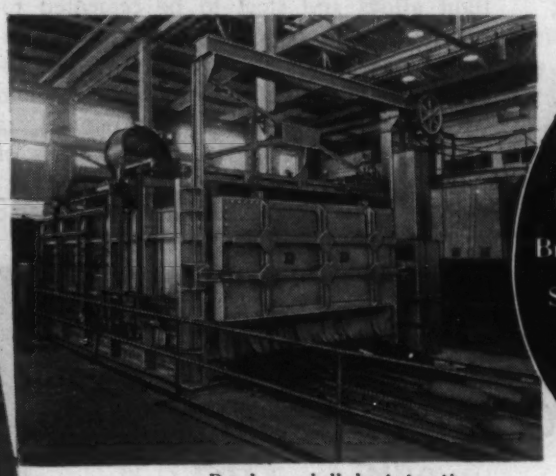
DEMPSEY industrial furnaces



Large-capacity air recirculating furnace with chain conveyor.



Bomb or shell heat treating furnace.

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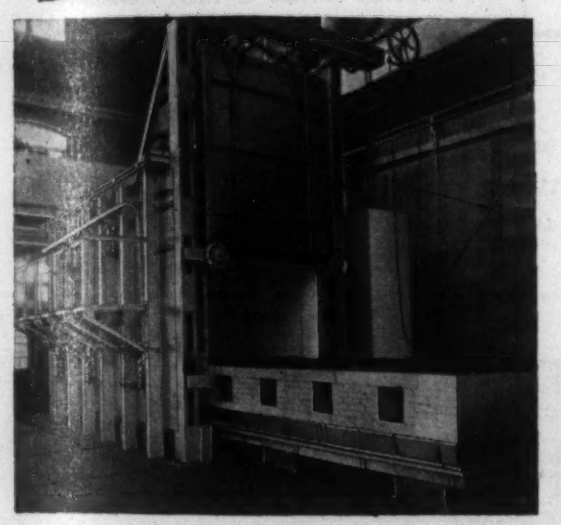

Over- and under-fired car type annealing, stress relieving and normalizing furnace.

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and many others. DEMPSEY installations cover every phase of heat treating. Whether the problem involves a small or large furnace, DEMPSEY engineers will design and install equipment to meet the requirements exactly.

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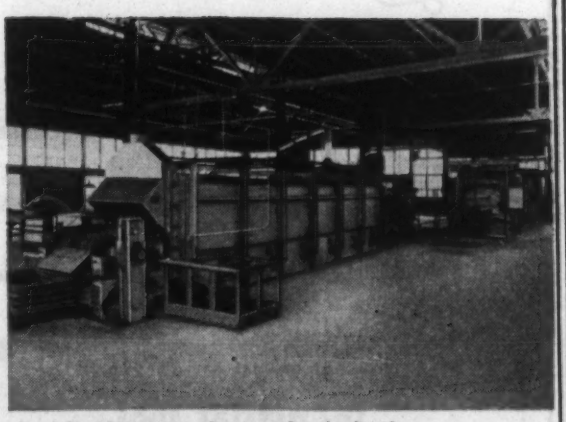
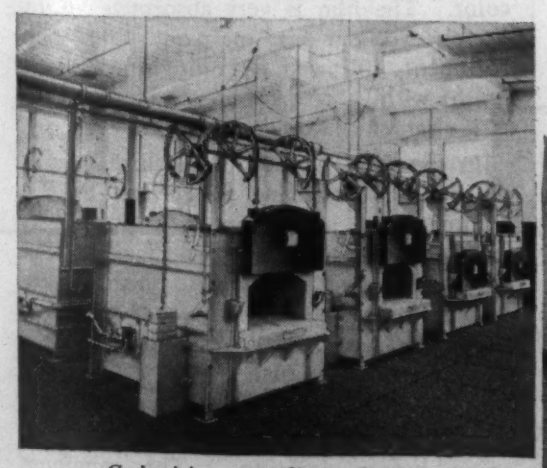
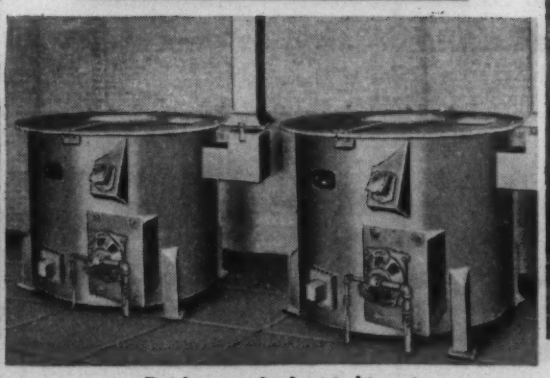


Continuous pusher type hardening furnace, automatic quench, and continuous belt conveyor type draw furnace.



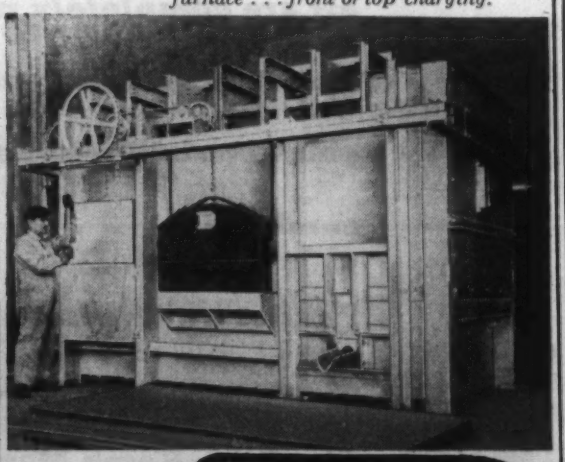
Carburizing, annealing and general heat-treating oven furnaces.

BUY WAR BONDS



Pot furnace for heat treatment in liquid bath.

Non-ferrous reverberatory melting furnace . . . front or top charging.



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installations working continuously under similar conditions and with the same material. Heating up to 500 deg. C. (930 deg. F.) operating temperature requires 3 hrs. for the air and 26 hrs. for the salt bath furnace, and cooling down to the soft-annealing temperature of 380 deg. C. (715 deg. F.) 1 and 10 hrs., respectively.

Although the mechanical properties of the material treated in the air furnace with spray quenching are somewhat inferior to those treated in the salt bath with water quench (tensile strength 40.9 against 41.6, and elastic limit 25.0 against 25.8 kg. per sq. mm.), the advantages of quick adaptability to new conditions, easy transportability, little radiation losses, freedom of danger of explosion or injury by spilled salt make the air furnace preferable in many cases. The energy consumption is 32,000 to 35,000 kw.-hr. per mo. as against 25,000 to 28,000 kw.-hr. and 1800 kg. salt per mo. (in two shifts).

—O. Ruder & J. Philippi. *Aluminium*, Vol. 24, Sept. 1942, pp. 315-321.

Adhesive Bonds for Metals

Condensed from "Sheet Metal Industries"

The article describes the Redux process, a method of resin-bonding which enables light alloys and steel to be cemented together, or to wood, without stress concentrations, to give joints which are aerodynamically smooth, gasoline-tight and stronger than comparable riveted joints.

In the examples given the thickness of the synthetic resin adhesive layer was 0.002-0.003 in. The joints were made in hydraulic presses heated to about 300 deg. F. for 20 min., at a pressure of 600 lbs. per sq. in. Pressure was released when the joints were cool. An apparent shear stress of 5,300 lbs. per sq. in. was obtained on a simple alclad lap joint, 1 in. wide with ½ in. overlap (6-gage strip).

The synthetic resin adhesives are unaffected by water, oil, or gasoline. Also they do not become brittle at temperatures below freezing. These adhesives work best with metals such as aluminum (dural), chromium, iron or steel, but give less satisfactory joints with brass, tin or zinc. The bond loses strength at temperatures above 210 deg. F., but regains the strength on cooling, provided the joint has not been subject to undue strain.

Further details are available from Aero Research, Ltd., Duxford, Cambridge, England. [*In the U.S.A. at least two resin bonding processes for metals are now available — The Reanite process of U. S. Stoneware and the Cyclewelding process of Chrysler and Goodyear.—Editors*]

—*Sheet Metal Inds.*, Vol. 17, July 1943, pp. 1209, 1232.

Black Finishes on Steel

Condensed from "Canadian Metals & Met. Industries"

Black finishes may fill one or more of the following purposes: (1) Improvement of the appearances of articles ordinarily left in plain steel, (2) increasing the rust resistance of steel parts, (3) production of a non-reflecting surface on military hardware, and (4) supplying a suitable base for paint.

The usual types of black finish are: (1) Black oxide finishes, (2) phosphate coatings, and (3) zinc plating, followed by blackening.

Black oxide finishes are widely used as substitutes for electroplated coatings. They bring about no dimensional changes, and paint adherence to the unoiled surface is good.

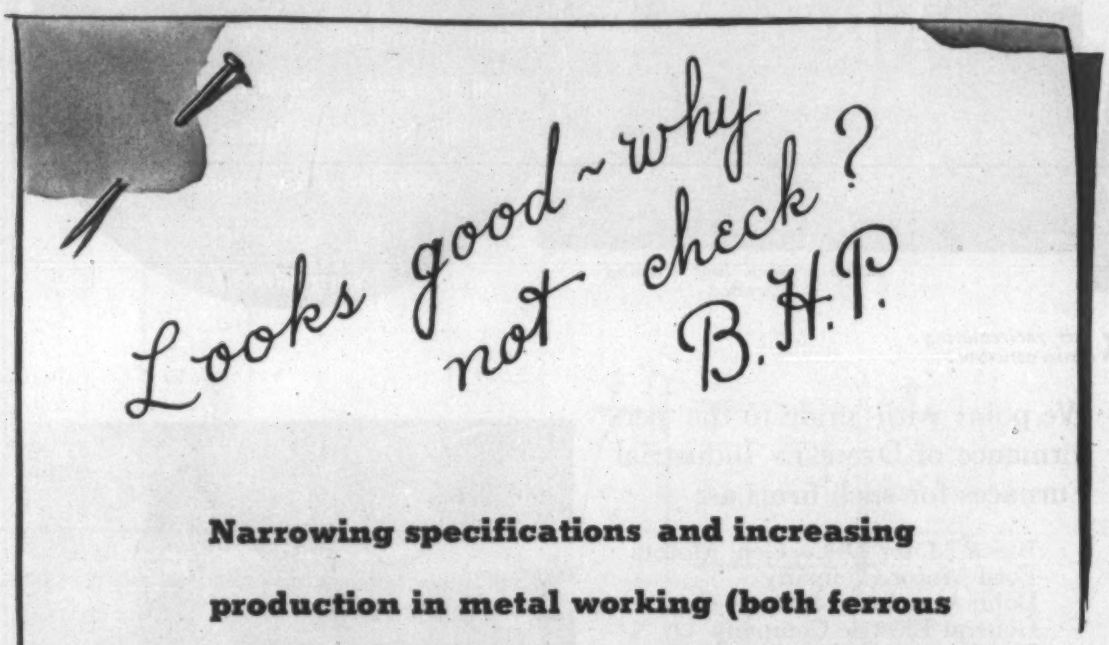
Phosphated steel has a dull nearly black color. The film is very absorptive affording an excellent base for paint. Phosphate treatment, followed by oiling, produces a finish with good rust resistance. There is a slight build-up in dimensions.

In the third method of blackening steel, the steel is first zinc plated and then is blackened by immersion in a proprietary bath to produce a jet black finish. The rustproofing value of this finish is extremely high and the corrosion resistance may be varied at will by control of the thickness of zinc plate used.

Greatly improved paint adherence may be obtained on zinc plated articles by blackening before painting. The minimum thickness of zinc plating for good rustproofing qualities is 0.0002 in.

All of these finishes have their place in defense production and the black oxide and the phosphate coating methods involve the use of no strategic materials. Zinc plating would be available only for priority work.

—A. C. West *Can. Metals & Met. Inds.*, Vol. 6, June 1943, pp. 32-33.



Narrowing specifications and increasing production in metal working (both ferrous and non-ferrous) make the Kemp Industrial Carburetor increasingly valuable as an industrial tool.

By means of the Industrial Carburetor, gas and air are *completely* premixed at a central station to provide any predetermined flame characteristics—reducing, oxidizing or complete combustion.

For descriptive bulletins, specific information or engineering assistance, address

The C. M. Kemp Manufacturing Company,

405 East Oliver Street, Baltimore-2, Maryland.

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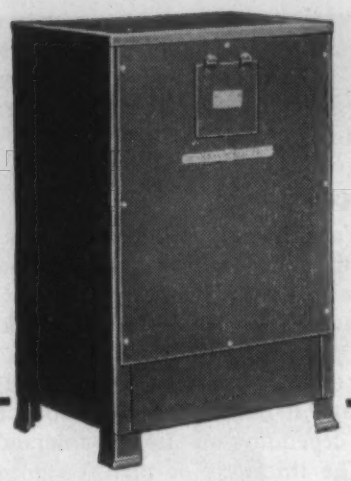
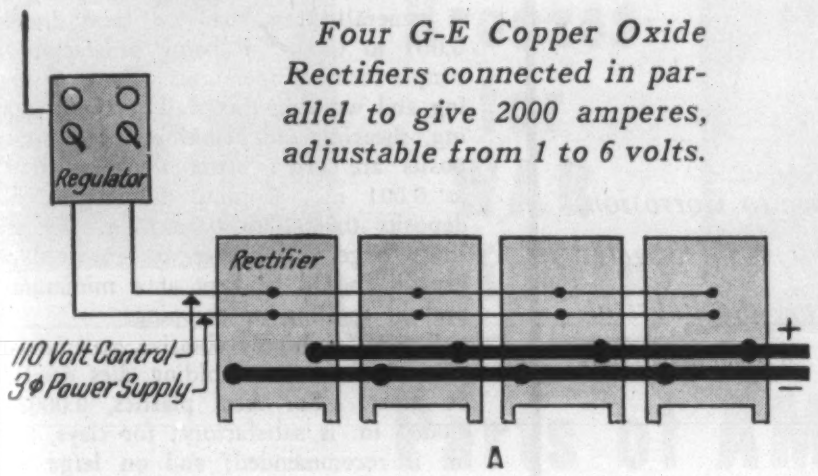


ONE TOOL FOR MANY JOBS

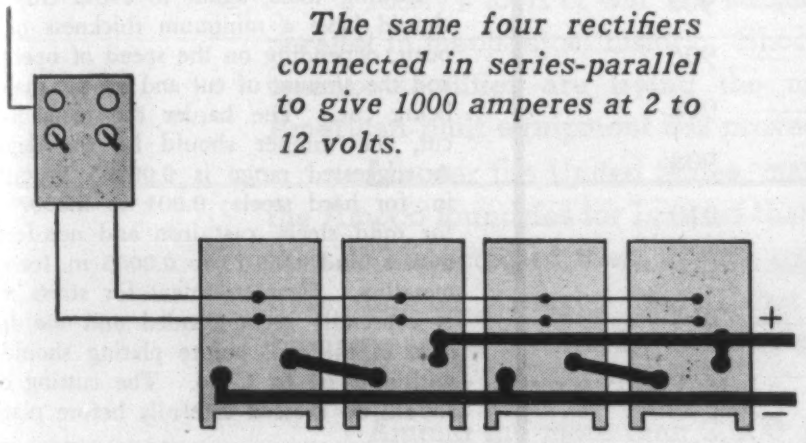
How one electroplater adapted General Electric Copper Oxide Rectifiers for various jobs, including still-tank plating, barrel plating and anodizing

Four G-E Copper Oxide Rectifiers connected in parallel to give 2000 amperes, adjustable from 1 to 6 volts.



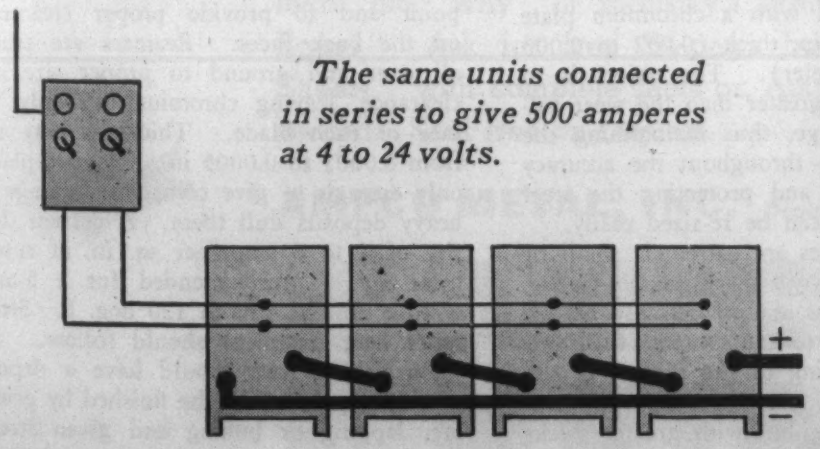
A

The same four rectifiers connected in series-parallel to give 1000 amperes at 2 to 12 volts.



B

The same units connected in series to give 500 amperes at 4 to 24 volts.



C

A. 6-VOLT TANK PLATING

By connecting four G-E Copper Oxide Rectifiers in parallel, the plater obtained 2000 amperes at from 1 to 6 volts for a still-tank plating job. The single regulator for the four units gave complete control over the full range output.

B. 12-VOLT BARREL PLATING

When a barrel-plating contract was obtained, it was a simple matter to rearrange the four rectifiers in series-parallel so as to secure 1000 amperes at from 2 to 12 volts required for the job.

C. ANODIZING

The same four rectifiers were also reconnected in series for an anodizing job requiring 500 amperes at 4 to 24 volts.

OTHER COMBINATIONS

These are only three common examples of the wide variety of groupings that can be obtained with G-E Copper Oxide Rectifiers to serve specific needs, including 40 volt anodizing.

Why not investigate the potential uses of G-E Copper Oxide Rectifiers in your electroplating? G-E Tungar and Metallic Rectifier engineers will be glad to consult with you. Write to Section A1034-12, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

Chromium Plate in Engineering ——— 902
Aluminum Alloys vs. SO_2 ——— 906
Behavior of Lead Bearing Alloys ——— 908
New German Aluminum Alloy ——— 908
Ersatz Piston Alloys ——— 910
Steam-Corrosion of Alloy Steels ——— 910
Design of D.C. Magnets ——— 914
Tin Conservation in Soft Solders ——— 916

Chromium Plate in Engineering

Condensed from an A. S. T. M. Paper

The general procedure for chromium plating as outlined in "Tentative Recommended Practice B 177" for "Chromium Plating of Steel for Engineering Use," needs to be complemented since conditions of service and the condition of the articles to be plated control the thickness and finish requirements of the plating. They vary among different articles even in the same type of service so that each application is an individual problem.

Wear Resistance

Most applications of chromium plate on steel for engineering use are made to obtain better abrasion resistance and to decrease wear on the article. Gages are generally finished with a chromium plate 0.001 to 0.0015 in. thick (0.002 to 0.003 in. on the diameter). The object is to have a thickness greater than the wear tolerance of the gage, thus maintaining the chromium surface throughout the accuracy life of the gage and protecting the steel so that the gage can be re-sized easily.

Where tolerances are extremely small or the gage must have a sharp working edge, the plate thickness should be only of the order of 0.0001 to 0.0003 in., to avoid chipping or spalling of the plate. In using thin deposits, the gage may be plated directly to size, but with greater thicknesses it is more practical to grind the gage undersize by the amount of plate thickness required, plate oversize sufficiently to give grinding stock and then grind or lap back to gage size. Generally a ground, lapped or honed finish is adequate but light buffing may also be desirable. A stress-relief heat treatment after plating is advisable.

Plugs and Dies

Tube-drawing plugs and dies are treated in the same way as gages, although dies may be used without grinding or finishing because a few passes of the work over the die produces a satisfactory finish. A typical thickness of deposits is 0.003 in., although it may vary from 0.0010 to 0.0005 in., depending on size and tolerances.

The thickness of plate on forming dies is generally less than on tube drawing, 0.001 to 0.002 in. being satisfactory for simple forming operations. For deep drawing and working thin-wall sections, stamping, shearing and blanking operations, deposits are often better down to 0.0002 to 0.001 in. Coining dies should have deposits 0.0002 to 0.0005 in. Wherever sharp edges or impact are involved, the deposit should be kept at a minimum to prevent spalling or chipping.

Except for highly abrasive materials, the plate thickness on molding dies need not be great. For most plastics, 0.0002 to 0.0005 in. is satisfactory; for clays, 0.002 in. is recommended; and on large work still higher values. An important factor is to finish to a high luster except where dull or special finishes are required.

Cutting Tools

Cutting tools, again to avoid chipping, should have a minimum thickness of deposit, depending on the speed of operation and the amount of cut and on the material being cut. The harder the metal being cut, the thinner should be the deposit. A suggested range is 0.00005 to 0.0001 in. for hard steels; 0.001 to 0.00025 in. for mild steels, cast iron and non-ferrous metals; and 0.00015 to 0.0005 in. for non-metallics. Heat treatment for stress relief is especially recommended and the hardness of the tool before plating should be within C 62 to C 64. The cutting edge should be dressed carefully before plating.

Special Applications

Twist drills are plated their full length, the flutes being completely covered. Generally no special sizing is required because of the thin plate. They should be dressed to remove chromium from the point and to provide proper clearances on the back faces. Reamers are plated all over and ground to proper size and clearance, leaving chromium on only the face of each blade. Thickness may run from 0.0001 to 0.0005 in. Files are plated only enough to give complete coverage as heavy deposits dull them. A current density of 4 to 6 amp. per sq. in. of superficial area is recommended for a 5-min. plating time at 100 to 120 deg. F. Stress relief heat treatment should follow.

Burnishing bars should have a deposit of 0.002 to 0.003 in., be finished by grinding, lapping or buffing and given stress-relief heat treatment. For pump shafts a thickness of 0.0005 to 0.0015 in. is satisfactory except for use under high pressure packing where they should have about 0.003 in. The finish should be buffed

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Frasse subsequently spent a day with the manufacturer's purchasing director, designers, and metallurgists, compiling "spec" conversion charts and revising prints. "Spec" checking with Frasse is now a regular process with this war contractor.

Frasse, incidentally, regularly issues identification charts showing up-to-date Government specifications for alloy, stainless and carbon steels—copies are obtainable free from any Frasse office. Meanwhile, why not (1) always mention the effective date of the specification to which you order, (2) keep posted by regularly checking your purchasing records and blueprints with Frasse. *Peter A. Frasse and Co., Inc., Grand Street at Sixth Ave., New York 13, N.Y. (Walker 5-2200) • 3911 Wissahickon Ave., Philadelphia 29, Pa. (Radcliff 7100 - Park 5541) • 50 Exchange Street, Buffalo 3, N. Y. (Washington 2000) • Jersey City, Hartford, Rochester, Syracuse.*

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to high luster. Pump plungers and hydraulic rams are handled similarly except that the plate thickness may run from 0.005 to 0.010 in. and even in extreme cases to 0.100 in. Many hydraulic parts which run through packing and have a deposit of 0.0005 to 0.00015 in., may be plated to approximate size and buffed. Those functioning inside a cylinder with close tolerance should be plated to oversize and ground to size with a residual plate of 0.001 to 0.003 in.

Most machine parts take approximately 0.0005 to 0.003 in. in thickness, and are finished smooth by grinding or lapping to size after plating. Steel engraved printing surfaces require a deposit of only 0.0002 to 0.0005 in. Heavier deposits cause loss of detail in fine etching.

Corrosion Resistance

Resistance to erosion, pitting and corrosion are also important factors in wear-resisting applications on molding die surfaces and on pump shafts, rods and plungers. Where the part is primarily plated for corrosion resistance with wear resistance a lesser consideration, the plate thickness varies from 0.0002 to 0.0005 in. for bearing rollers operating in oil, to 0.010 to 0.015 in. or more on large rolls and operating equipment.

Salvage

The number of salvage applications is practically unlimited, covering parts worn in service and those machined off-size. The thickness requirements are determined by the amount the part is off-size except where the maximum thickness that will function satisfactorily is less than the amount which has to be built up.

T. G. Coyle, *Am. Soc. Testing Materials, Preprint No. 29,* June 1943 meeting, 6 pp.

Aluminum Alloys vs. SO_2

Condensed from "Aluminium"

The corrosion resistance of aluminum and aluminum alloys in a wet SO_2-containing atmosphere was tested and the protective action of different surface treatments determined. The materials tested were pure Al (99.8). Al-Cu-Mg (Duralumin ZB ⅓), Al-Mg (hydronalium 7), and Al-Mg-Si (legal II) in the form of sheets 1 mm. thick, 120x60 mm., with the following surface treatments: (1) No protection, degreased in trichlorethylen; (2) Eloxated by the G. S. process, 1.5 amp. per sq. dm., 30 min., densified 30 min. with bichromate at 95 deg. C. (200 deg. F.). (3) Treatment as under (2) and protected with clear cellon lacquer (one spray and dried in air). (4) Al-Cu-Mg sheets (duralumin), sandblast, one spray of clear cellon lacquer and dried in air.

The samples were placed in an atmosphere containing about 2.8 per cent SO_2 at 23 deg. C. (73 deg. F.). All materials were attacked in the not protected condition, strong pitting occurred particularly in duralumin, less in aluminum, and legal hydronalium showed only little roughening and uniform wear. The uniform decrease in thickness was greatest in Al-Mg 7, less in aluminum and legal, and practically none in duralumin.

Lacquering with cellon alone did not

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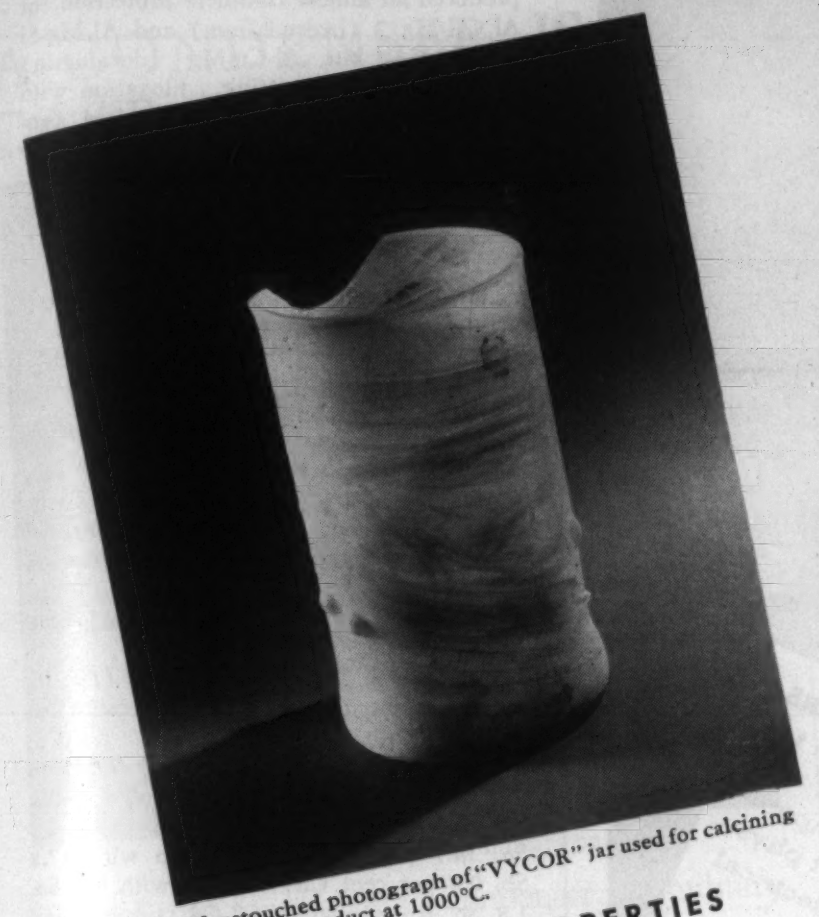

Unretouched photograph of "VYCOR" jar used for calcining a mineral product at 1000°C.

Use "VYCOR" brand Glassware at continuous operating temperatures up to 900°C. It will stand up to 1200°C. for shorter periods in some instances. It can take it and here's proof: heated to cherry red, it can be plunged into ice water without breaking.

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PHYSICAL PROPERTIES

Softening point, approx.	1500°C.
Linear Coefficient of Expansion per °C.	0.0000008
Specific Gravity	2.18
Refractive Index	1.458
Tensile Strength	Comparable to Pyrex Chemical Glass No. 774
Loss in Weight on Heating and Cooling	Negligible
Visible Light Transmission for 2 mm. thickness	92%
Ultra Violet Transmission at 254 millicmicron line for 2 mm. thickness	2 to 4%
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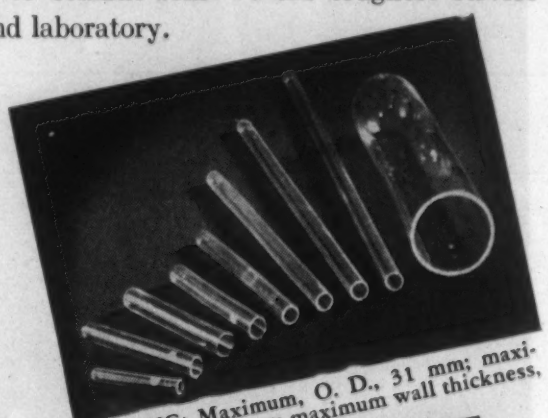
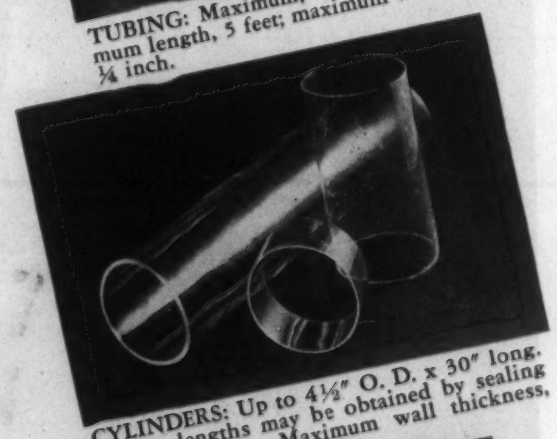
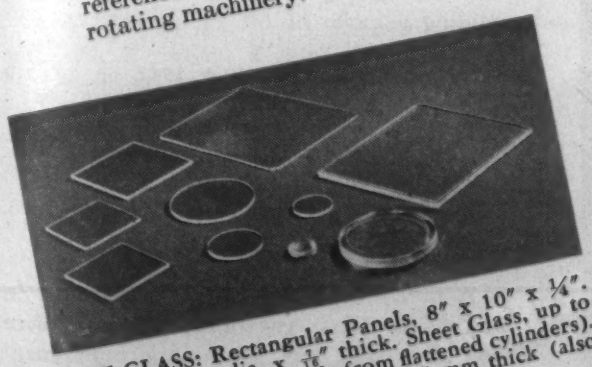
High temperature gas sampling tubes . . . Thermocouple sheaths . . . Radiant heating element sheaths . . . Sight Glasses for high temperature furnaces and chemical processing equipment . . . Pilot plant and small plant-scale fusion and sintering operations . . . Reaction-vessel tubes for high temperature control instruments . . . Low expansion reference rods in temperature control . . . Mechanical seal-rings for pumps and other rotating machinery.



TUBING: Maximum, O. D., 31 mm; maximum length, 5 feet; maximum wall thickness, ¼ inch.



CYLINDERS: Up to 4½" O. D. x 30" long. Longer lengths may be obtained by sealing pieces together. Maximum wall thickness, ¼ inch.



FLAT CLASS: Rectangular Panels, 8" x 10" x ¼". Roundels, 5⅛" dia. x $\frac{1}{16}$" thick. Sheet Glass, up to 15½" x 15½" x ⅛" (made from flattened cylinders). Standard Squares, 5⅝" x 5⅝" x 7 mm thick (also 3, 4 and 6 mm thick).

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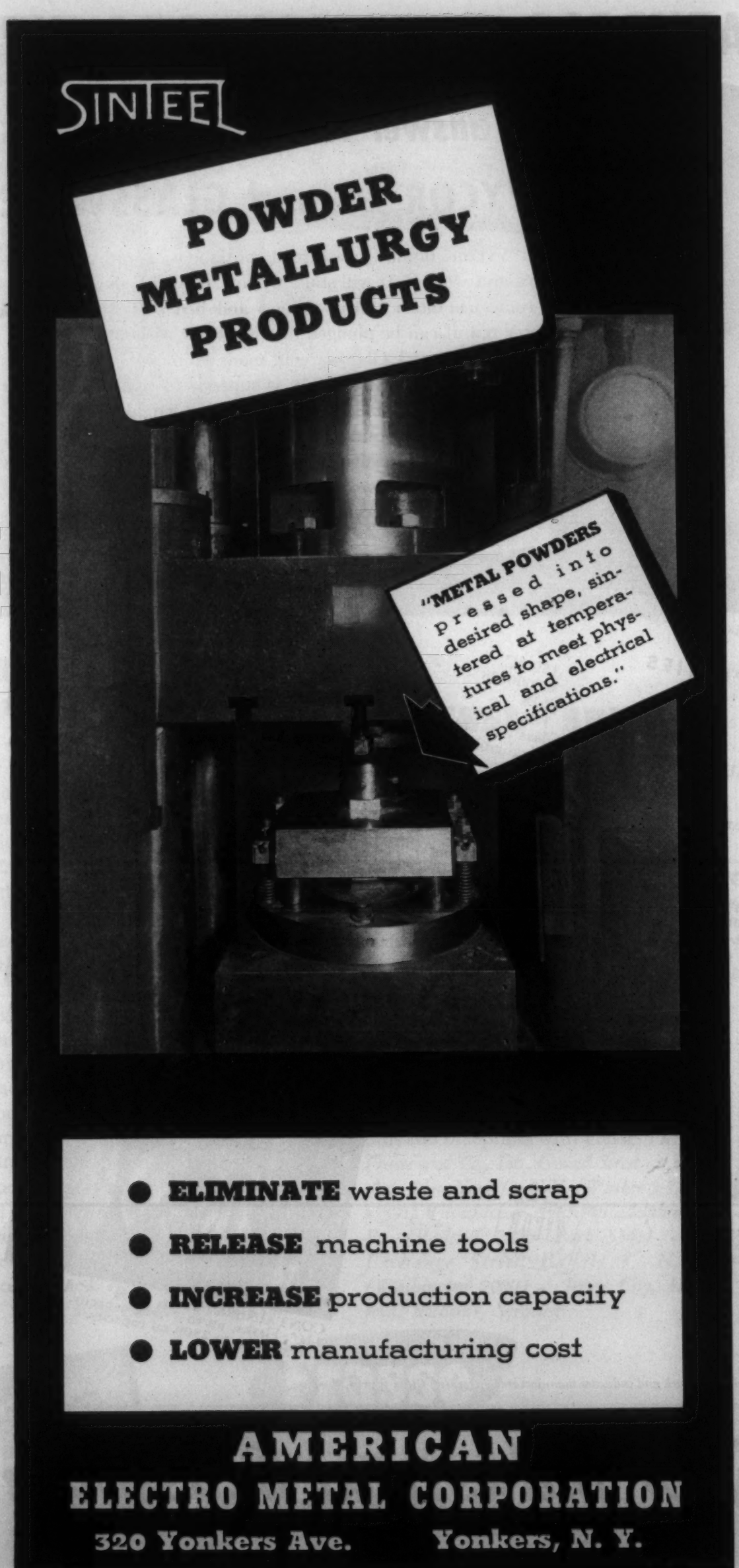

reduce the attack noticeably. Eloxation with subsequent bichromate densification produced an almost complete protection for Al, Al-Mg 7 (hydronalium) and Al-Mg-Si (legal II), but Al-Cu-Mg (duralumin) showed still some pitting. Eloxation with additional lacquering was complete protection, duralumin alone showed after some length of time an attack at the edges.

—L. Koch & E. Fenner, *Aluminium*, Vol. 24, Oct. 1942, pp. 354-357.

Behavior of Lead Bearing Alloys

Condensed from "V.D.I. Zeitschrift"

In order to find out in which way expensive tin in bearing alloys can be replaced by cheaper metals on a lead basis, tin-rich and poor alloys were investigated with respect to the gliding properties in sleeve bearings and compared with the standard white metal WM8OF, of 80.2 Sn, 11.2 Sb, and 8.6 per cent Cu.

The alloys investigated were (1) Pb with 9.6 Sn, 14.0 Sb, 1.7 per cent Cu; (2) Pb with 9.5 Sn, 15.2 Sb, 1.7 Cu, less than 0.03 per cent C; (3) Pb with 5.9 Sn, 15.6 Sb, 1.1 Cu, 1.7 Cd, 1.0 Ni, and 0.5 per cent As; (4) Pb with 2.8 Sn, 14.7 per cent Sb; (5) Pb with 17.8 Sb, 0.8 per cent Cu; (6) Pb with 0.5 Sn, 1.8 Sb, 0.1 Cu, trace of Cd, 1.4 Ni, and 0.9 per cent As; and four other lead alloys with 0.4 to 0.6 per cent Sn and less than 1 per cent other additions.

The running tests with static load showed that the properties of these alloys equal those of the high tin alloys, and, in some cases, are even superior. In regard to running-in, WM8OF is reached by alloys Nos. 1, 2, 3, 6, and some of the other lead alloys. The emergency behavior of all tested alloys was about equal to WM8OF. They could be loaded equally high and even higher.

With regard to wearing (abrasion) resistance, the white metal is superior to Nos. 1, 2 and 4, equal to Nos. 5 and 6, and surpassed by No. 3 and some of the other low tin alloys; the tests were made at a gliding velocity of 0.1 m. per sec.

—E. Schmid & R. Weber, *Z. Ver deut. Ing.*, Vol. 86, Apr. 4, 1942, pp. 208-210.

New German Aluminum Alloy

Condensed from "Aluminium"

A new alloy (aluminum with 4.5% Zn and 3.5% Mn) was developed to replace an alloy of the aluminum-copper-magnesium type for airplane construction and to have at least 55,000 lbs. per sq. in. tensile strength, 35,000 elastic limit and 15 per cent elongation. Additions of chromium, copper and manganese increase mechanical strength; chromium has the greatest and manganese the least effect, while vanadium has practically no influence on mechanical properties.

Room-temperature age-hardening requires long time periods, and is not complete after 150 days, although nearly so. A temperature rise of 20 deg. F. in the temperature range of about 50-120 deg. F. produces an increase in elastic limit of

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Note the complexity of the housing casting

Today's use for the above condenser is a military secret. It must suffice to say that it has an important role in radio equipment used by our armed forces. We are, however, permitted to point (with pride) to the 2 zinc alloy die castings used in this assembly.

An accuracy of 1/100 of 1% must be maintained on the calibration of the condenser, and the zinc alloy die castings (foreground) materially facilitate this extreme accuracy. Design engineers have come to expect close dimentional limits in complicated zinc alloy die castings. The main housing casting of this condenser is just one more application which indicates they are getting it!

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METALS AND ALLOYS EDITION **No. 14**

A CABLE CONNECTOR IS DIE CAST FOR ECONOMY

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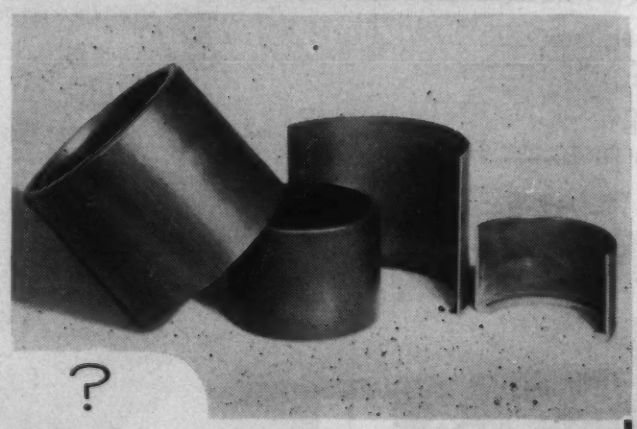

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1,000 to 3,000 lbs. per sq. in. Room-temperature age-hardening starts after a definite incubation time of about ¾ hr.

No influence of solution-annealing temperature on the mechanical properties could be established between 750 and 925 deg. F., also, variations in the commercial annealing temperature range at a temperature of 825 deg. F. were without effect.

Cooling in air does not always give satisfactory values of mechanical strength, so that water-quenching is preferable. The soft-annealing temperature is 600 deg. F. Room-temperature age-hardening is disturbed by cold-working.

—H. G. Petri, G. Siebel & H. Vosskuhler. *Aluminium*, Vol. 24, Nov. 1942, pp. 385-289.

Ersatz Piston Alloys

Condensed from "Metallwirtschaft"

This is a general review of the efforts to replace strategical alloying elements or reduce them to minimum amounts in light alloys, especially of the aluminum-copper and aluminum-copper-nickel, aluminum-silicon and aluminum-magnesium alloys for pistons.

Good results were obtained with an aluminum alloy containing 4 Cu, 2 Ni, 1.5 Mg, up to 0.15 per cent Ti and other additions; or 13 Si, 0.8 Cu, 1.7 Ni, 1 Mg, up to 0.6 per cent Fe; or 17 Si, 3.2 Ni, 0.8 Cu, 0.4 Cr, 0.4 Mn, 1 Mg, up to 0.8 per cent Fe; or 5 Mg, 1.0 Si, 0.1 Mn, 0.1 per cent Ti, strategic material 0.25 or 0.5 per cent. Complete physical data are given for each composition.

—M. Kuhm & E. Nitzsche, *Metallwirtschaft*, Vol. 21, July 24, 1942, pp. 435-444.

Steam-Corrosion of Alloy Steels

Condensed from "Transactions," American Soc. Mech. Engrs.

Very extensive tests were made to determine the relative resistance to corrosion by steam of unstressed specimens of various alloy steels at 1500 and 1800 deg. F. Five hundred hr. tests were made with steels containing up to 18 per cent Cr, and 500 and 1300 hr. tests with 25-20 and 25-15-2 (Cr-Ni-W) steels.

All of the steels tested except the two latter specimens start to corrode rapidly at some temperature less than 1800 deg. F.; the temperature at which rapid corrosion begins increases with chromium content. An 18-8 columbium-bearing steel showed the same tendency toward rapid corrosion above some limiting temperature that the low-carbon steel showed at a much lower temperature.

The 25-20 and 25-15-plus 2W steels are extremely resistant to steam corrosion up to temperatures around 1800 deg. F. for an exposure time of 1300 hr. Photomicrographs indicate that no significant increase in grain size occurred in the straight 25 Cr-20 Ni steel; this is as can be expected as the grain size of the original steel was established by heating at 1900 deg. F. prior to steam-corrosion treatment at 1800 deg. F.

—G. A. Hawkins, H. L. Solberg, J. T. Agnew and A. A. Potter, *Trans.*, Am. Soc. Mech. Engrs., Vol. 65, May 1943, pp. 301-308.

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Design of D.C. Magnets

Condensed from "Electrical Engineering"

Direct current magnet design is of tremendous importance today because of the almost exclusive use of d.c. power in mobile equipment, such as tanks and airplanes. Magnets are the backbone of the d.c. control systems, for, when energized by push buttons or interlocks, they furnish the power to operate contactors and relays of all descriptions or to perform mechanical functions, such as actuating firing pins or locking devices. Such applications require light weight, minimum volume, insensitivity to vibration with the magnet open or closed, higher operating temperatures, etc.

The diversity of design requirements has led to a large number of different forms of magnets. It is impossible to find a design procedure suitable for all cases, but the same factors, such as saturation, leakage, residual forces, and kind of steel, must be considered in each.

Aging factor is defined as the percent increase in hysteresis loss which occurs to a steel with time. An accepted laboratory method of finding the aging factor is to measure the d.c. hysteresis loop before and after holding the steel at 100 deg. C. for 600 hrs.

Magnetic Properties of D.C. Magnet Steels

Steel or Iron	Intrinsic Saturation (Kilolines per sq. in.)	Aging Factor (Per Cent)	Residual Induction (Kilogausses)	Coercive Force Oersteds)	External Energy (Maximum)
Plain (C. R.) steel	133	15	7.9	1.5	4.650
0.25-0.75 Si	132.3	8	8.37	0.86	3,450
0.75-1.25 Si	131.5	5	8.0	0.70	2,400
2.50-3.0 Si	126	3	8.1	0.67	2,450
Ingot iron	135.5	Varies	7.5	1.05	2,330
50 Co	148		16.5	3.5	25,800

Materials

Cold-rolled steel is the most widely used for d.c. magnets because of its low cost, and its desirable mechanical qualities. It is readily drawn, punched, or formed, and is available in many forms and sizes. As, however, the mills do not guarantee its magnetic qualities, large variations can and do occur in the magnetic quality of this steel.

In general, in the annealed condition, cold-rolled steel has a better magnetization curve for the higher densities and a higher saturation value than the silicon steels. Its coercive force and its available external energy are high, and its aging factor is large. A design using this material must be checked carefully, not only for residual forces at the time of manufacture, but also for increased forces which may develop because of aging.

As the percentage of silicon in steel increases, the saturation curve becomes poorer, and the intrinsic saturation falls. Silicon steels are also harder to fabricate. Silicon steels, however, are sold with specified magnetic properties and are of consistent quality. Aging factor, coercive force and external energy are considerably less for silicon steel than for cold-rolled steel.

Ingot iron is one of the purest forms of iron sold commercially. When properly annealed, it has the best magnetization curve and the highest intrinsic saturation value of the usual steels. It is ductile and tough, but readily forged, machined or welded. Its external energy curve is low. Its main disadvantages are its relatively high cost and lack of availability in various forms and sizes.

Special high-saturation steels are relatively difficult to obtain; they are expensive, have poor machining properties, and high coercive force and residual induction. However, a 50 per cent cobalt, 50 iron has a remarkably good induction curve and high intrinsic saturation.

Design Factors

In all d.c. designs, especially in those using cold-rolled steel, it is essential for consistent performance that an air gap be in the circuit between the armature and pole face. The order of magnitude of residual forces is often underestimated. In one case a magnetic circuit of ingot iron weighing 5 lbs. 2 ozs. was found to have 33 lbs. residual force when there was no air gap in the circuit. In another case a small relay using annealed stamping steel

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Micarta *The* **INDUSTRIAL PLASTIC**

weighing 32 grams had a measured residual force of 112 grams.

When a magnet operates, the repetitive shock of one part on another, together with the simultaneous application of magnetic field, tends to increase the coercive force. It has been found in practice that this increase may be considerably more than the aging factor would indicate.

D.c. magnets can be classified into two general groups:

(1) Clapper or pivoted armature type.
(2) Solenoid or pot type.

Design requirements for a magnet are usually: (a) It should give a force-versus-stroke curve suitable for the particular requirement; (b) it should utilize to the fullest extent every ounce of iron and copper in the magnet; and (c) it always should release under the action of the restoring spring when de-energized.

The requirements determine whether a clapper or solenoid magnet will be used. The shape of the pull curve of a clapper magnet can be changed by varying the pole-face area; that of a solenoid type by using some variation of a stepped plunger or conical plunger.

—L. T. Rader. *Elec. Eng.*, Vol. 67, June 1943, pp. 307-310.

Tin Conservation in Soft Solders

Condensed from an A.S.T.M. Paper

In the absence of a plentiful supply of tin much of the work formerly done by high-tin solders can be performed by solders of alternate compositions containing either no tin at all or much less than was previously used. Also much of the residual demand for high-tin solders can be eliminated if proper methods of using alternate compositions are installed.

In many cases assemblies can be designed to take advantage of other methods of joining and eliminate the soldering operation entirely. Spot welding and seam welding are used on many truck fuel tanks and could be used on more sheet metal structures. By ingenious design, cemented crimped joints sometimes give better results than solders. Silver brazing by electrical resistance methods is replacing soft solder in the electrical field. Copper hydrogen brazing may be considered where equipment is available and production sufficiently great.

Lead-Tin Solders

A solder is judged largely by the solidus and liquidus temperatures, giving the melting range, and the ability of the solder to alloy with the base metal. In the lead-tin system, the eutectic occurs at 62 per cent Sn and 361 deg. F. The solidus is horizontal at this temperature from 19.5 per cent to 97.4 per cent Sn. In a 60-40, 50-50 or 40-60 Sn-Pb alloy, the proportion of tin to lead can be lowered to 19.5 per cent without changing the solidus, but the liquidus rises steadily giving a wider freezing range and high flow temperature. During the freezing period the solder has practically no strength. "Hot shortness" difficulties can often be eliminated by maintaining rigid alignment of joint members until complete solidification. The higher liquidus temperature necessitates higher heat input during the operations. Below 19.5 per cent Sn, the solidus rises abruptly, narrowing the freezing ranges.

Antimony is cheaper than any other metal commonly used in solders except lead. It alloys with iron and copper and in most solders, it lowers the liquidus temperature. In some it raises the solidus temperature, narrowing the freezing range. S. J. Nightingale reports that the tin content can be reduced by 2 per cent for every 1 per cent of antimony added until the antimony content reaches 6 per cent of the tin content.

High lead-silver alloys have been used successfully in applications such as airplane radiators and electric motors where maintenance of strength at elevated temperatures is required. As most lead-silver solders are of a composition close to the eutectic — 97.7 per cent Pb, melting at 579 deg. F. — the melting range is narrow. Higher liquidus temperatures also require higher soldering temperatures. To correct this, tin and antimony are sometimes added.

The straight lead-silver alloys can be used on brass, copper, tin plate, hot-dip lead coatings, copper plate, or silver plate, with slight modification of usual techniques. Dip and torch methods do not give good results on uncoated steel. For dip soldering at high temperatures, alloys containing 0.5 to 1.25 per cent Sn, remainder lead, appear to be promising. At lower temperatures the tin content can be increased to 15 or 20 per cent.

Some can makers start with a solder containing 2.5 per cent Ag and 97.5 per

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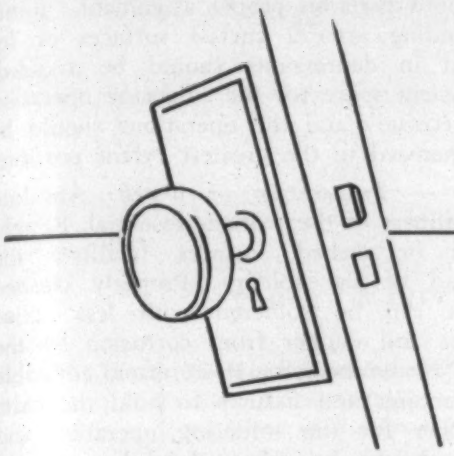

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cent Pb. The bath picks up tin from the tin plate to a concentration of about 5 per cent. Joints made with this are reported about 10 per cent stronger than those made with conventional tin-lead solders. The reduction in tin consumption from 4.07 lb. to 0.80 lb. of tin per thousand cans is largely due to the use of the electrolytic plate bodies and bonderized ends, but the use of tin-free solder accounts for 0.40 lb.

In many cases it is reported that silver imparts increased strength and improved creep resistance. Solders, containing 5 and 10 per cent Sn with 1 per cent Ag, the remainder lead, have been used experimentally for face dipping composite steel and brass radiator cores. They exhibit good capillary and wetting characteristics. If the silver content is too high, silver-tin needles are formed which produce detrimental properties. Small additions of antimony to these solders appear to produce good results for many types of applications.

The use of low-tin solders does not involve additional expense. In fact material cost is usually less, as the silver additions are small and the tin reductions large.

Soldering Methods

To use low-tin solders successfully it it first necessary to realize their fundamental differences and choose methods to overcome them:

A — *Design:* Faulty design is often re- joints and simple lap joints should be avoided. Tack brazing, spot welding, riveting and sheet metal screws can be used to hold parts in proper alignment. Joints extending around curved surfaces or located in depressions should be avoided. Sufficient space for the soldering operation is necessary and the operations should be mechanized to the greatest extent possible.

B — *Preparation of Work:* Absolute cleanliness of the work is essential. Roughened or etched surfaces facilitate the spread of the solder. Properly cleaned work can be soldered with less active fluxes and danger from corrosion by the flux is diminished. It is often advisable to use jigs and fixtures to hold the parts together for the soldering operation and care should be taken that they are of proper design and not too difficult to use. They should be insulated where heat losses can occur.

C — *Fluxes:* Rosin-base fluxes decompose readily with heat to form an inert, moisture-impervious residue. The most widely used fluxes are of zinc chloride and ammonium chloride with a small amount of free hydrochloric acid. These fluxes are corrosive and hygroscopic. They may be used as emulsions with greases, in aqueous solutions or in the molten condition. The work should be neutralized and thoroughly washed. Electrical resistance and induction heating methods, giving rapid heating, may be adapted to many soldering operations. The use of inserts or gaskets of solder foil is helpful.

D — *Wiping Solders:* In wiping solders the frequently claimed need for more than 30 per cent Sn seems questionable. A 30-70 Sn-Pb solder has the same solidus as a 40-60 one and a higher liquidus giving a wider freezing range. Addition of 2 per cent Sb is said to improve it. In many cases wiping solder may be eliminated by using lead welding. Also, by a study of joint design, the amount of wiping solders required may be reduced greatly.

E—*Other Methods of Soldering:* When assemblies are such as to hold themselves in the proper position, bake or furnace soldering may be used. By using higher soldering temperatures, the low-tin solders and in some cases the high lead-silver have been successfully used in this way. The dip method is frequently used for small parts where the operation is repeated. With higher operating temperatures and proper flux concentration, very low tin content baths have been successful.

F — *Hand Iron Soldering:* Many hand iron soldering applications can be more readily performed with the gas torch. A reducing flame is recommended. In hand iron soldering, brittle or cracked solder or failure to "stick" are usually due to an insufficiently heated iron. A low-tin solder requires greater heat input.

—D. L. Colwell & W. C. Lang. *Am. Soc. Testing Materials, Preprint No. 35,* June 1943 meeting, 6 pp.

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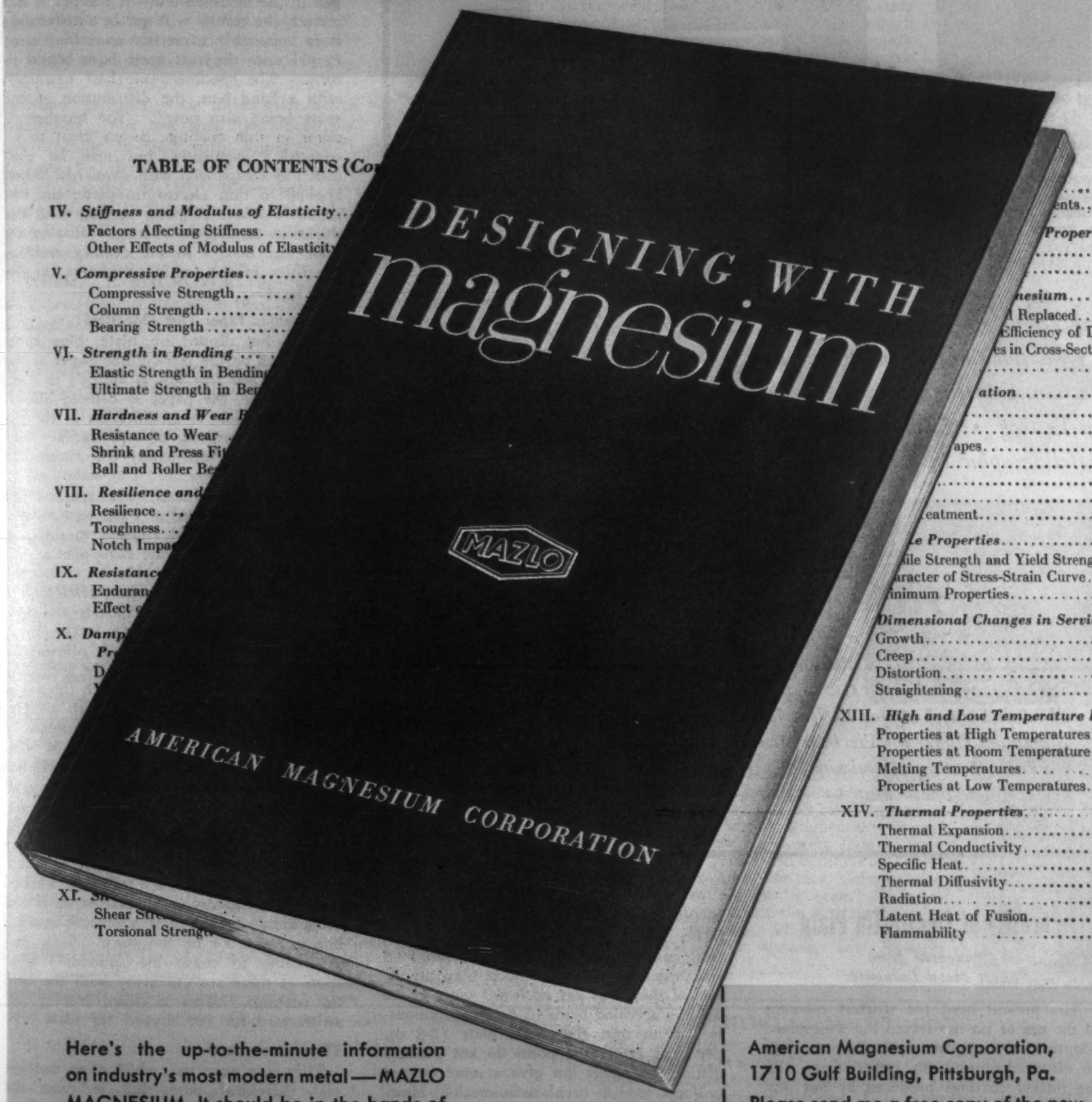

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Porosity of Electro-Tin Plate

Condensed from "Sheet Metal Industries"

The present need for strictest economy in the use of tin has forced the widespread adoption of tin plate with thin coatings of electro-deposited tin rather than with the thicker coatings produced by hot dipping. Obviously, the continuity or lack of porosity of the thin tin coatings is important from the standpoint of corrosion resistance. Two of the standard tests for hot dipped tin plate have been modified to be applicable for electro tin plate with much thinner coatings, while a third test has been devised which is satisfactory for both.

Hot Water Porosity Test (Modified)

In the regular hot water porosity test, rust spots develop at the pores in the tin coating after several hours immersion in distilled water at 95 deg. C. (200 deg. F.). With hot-dipped tinplate, the pores are well defined and have a certain minimum size, whereas with electro-deposited tin the size of the pores has no lower limit so the number revealed tends to grow continuously. With thin electro tin plate (2-8 oz. per basis box), the pores do not produce distinct red spots but give a more or less uniform reddish or black coloration. However, if an oxide film is formed on the tin before the test, the rust spots are formed in a much shorter time and are less diffuse.

Therefore, the directions for the modified test are: The specimen is cathodically degreased in cold 1 per cent sodium carbonate, rinsed, and pre-filmed by immersion for 5 min. in 10 per cent chromic acid at 90 deg. C. (194 deg. F.). It is rinsed, first in running tap water and then in distilled water, and then immersed in distilled water (pH 4.5 to 5.5) contained in either a beaker or a tinned copper tank, and maintained at 95 deg. C. (194 deg. F.) for 40 min. (60 min. for hot dipped tin plate).

There should not be too many samples in the beaker or tank so there is an adequate supply of dissolved oxygen. Since there are more pores in the thin coatings, there is a much greater demand for oxygen in the modified test. If the pH is not correct, the results will not be satisfactory; it is impossible to rectify an initial error in pH once the rust spots have begun to form. The specimens are best examined with a hand lens, the distribution of the spots being also noted. The number of pores in thin coatings is too great to be counted conveniently, but may be estimated by comparison with standards. When applied to thin electro tin plate, the test reveals numbers of pores varying with the thickness of the tin coating. It also reveals any defects in the coating and inequalities in the coating thickness on the two faces.

Ferricyanide Paper Test (Modified)

With hot dipped tin plate, blue spots are formed on the ferricyanide paper at the pores. When this test is applied to electro tin plate, the paper is colored almost uniformly blue. A modification in the solution and method of application have made this test satisfactory for electro tin plate.

In the modified test: The specimen is cathodically degreased in 1 per cent sodium carbonate, rinsed and allowed to dry. A piece of paper about the same size as the specimen is soaked in a solution containing 10 g. per liter of potassium ferricyanide, 5 g. per liter of sodium chloride and 5 g. per liter of Tergitol 08 (a textile penetrating agent). The paper is allowed to drain for 5 sec., then laid on the specimen. Air bubbles are worked out with the finger tips. The paper is covered with a sheet of blotting paper and a roller squeegee is run across. The blotting paper is then removed and the ferricyanide solution brushed on to the paper until it is uniformly covered.

The paper is left in contact with the specimen for 10 min., fresh solution being brushed on if necessary to keep it moist. Afterwards, the paper is removed, washed and allowed to dry. The best paper is one with a fine texture and a smooth surface but it must not be too thick. It is impracticable to count the individual blue spots as there are too many with the thin tin coatings. This modified test is not satisfactory for hot dipped tin plate.

Thiocyanate Test

This is a new test which does not reveal individual pores but indicates the amount of iron exposed at the surface. The specimen (8 by 6 cm.) is degreased cathodically in cold 1 per cent sodium carbonate and the edges are stopped off with hard paraffin wax. It is then placed in a 300 cc. tall beaker containing 250 cc. of a solution of 20 g. ammonium thiocyanate, 10 g. glacial acetic acid, 10 g. per liter of hydrogen peroxide (20 vd.) The exposed iron is attacked by the acetic acid, the action being accelerated by the hydrogen peroxide which also oxidizes ferrous ions to the ferric state, producing a red coloration with the thiocyanate. After

MICROMAX AND OTHER L&N PYROMETERS

MODEL S MICROMAX automatically records one temperature, or as many as 16, on a wide, easily-read chart; indicates clearly on a straight scale 9⅞ inches wide. It can operate external signals, and simple or elaborate automatic controls, including electrically and pneumatically-operated *proportional* controls with automatic droop-correction. For use with thermocouples, see Catalog N-33A; with Rayotubes (radiation thermopiles), Catalog N-33B; with Thermohms (electrical resistance thermometers), Catalog N-33C. When used as a potentiometer (with thermocouple or Rayotube), Model S checks its circuit against a standard cell at frequent, regular intervals, and adjusts current automatically.

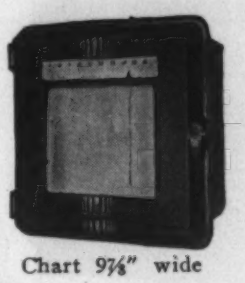
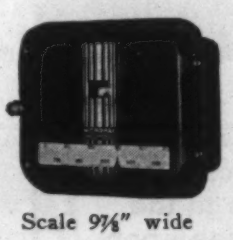


Chart 9⅞" wide

MODEL R MICROMAX indicates on an extra-long circular scale, readable across a large room; records one or two temperatures on a 24-hour round chart. Used with same temperature detectors as Model S. Can operate external signals, and most automatic controls. Model R has an indicating scale nearly three times as long as that of Model S, but the graduated width of its round chart is only about one-third that of the strip-chart. Current standardizing is manual. Like every Micromax, Model R has the sturdy, reliable mechanism which has made these instruments standards of accuracy and dependability.

Chart diameter 10"

MODEL C MICROMAX is particularly adapted to applications where a controlling instrument must indicate, but need draw no record. A single-point instrument, it indicates on a clearly legible straight scale, 9⅞ inches wide, and can handle a variety of automatic controls. Can be equipped to operate signals. Self-standardizing potentiometer circuit. Control is set by turning a knob on front of case until a red pointer stands at the desired control point on the instrument's scale.



Scale 9⅞" wide

MODELS N AND NC MICROMAX are used where nothing but control is desired — no indicating, no recording. Operate two-position controls only. Supplied for use with thermocouples or Thermohms.

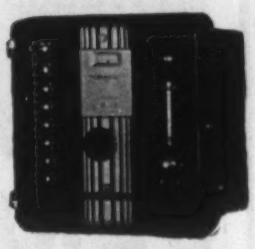
Overall width 15"

Model N, illustrated at right, is equipped with mercury control switch. Hand-standardized potentiometer circuit, when used with thermocouples. Control-point setter is inside the case

Model NC (in a case like that of Model C shown above) is available either with mercury control switch or with open-type control contacts. Control-setting dial and scale on front of case. Self-standardizing potentiometer circuit.

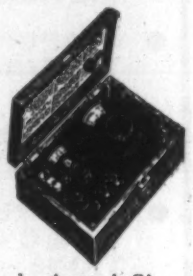
Jrl. Ad-N-33(41)

MANUALLY-OPERATED INDICATORS, for thermocouples or Thermohms, single or double range, read directly in temperature degrees. Portable indicators are completely self-contained, light enough to carry and use anywhere. Permanently installed indicators, equipped with selector switches, enable an operator to measure, from one central location, temperatures at many scattered points. He simply switches to a selected point, turns dial until galvanometer balances, reads temperature. Panel type, illustrated above, supplied with switches for a maximum of 18 couples. For measuring a greater number of points, a cabinet-mounted indicator, in a case like that of Model S, is supplied. **Also available is an automatic indicator,** for rapid measurement of a large number of thermocouple temperatures; operator simply snaps a switch, and the Micromax mechanism moves a pointer to the selected thermocouple's temperature. See Catalog N-33A(5).



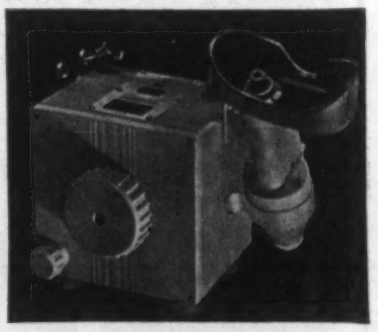
Overall width 11⅛"

APPARATUS FOR CHECKING thermocouple pyrometers includes potentiometers, standard thermocouples and accessories. Potentiometers, calibrated in millivolts for use with any couple, are available in portable and table models, with ranges and accuracies suitable for tests in plant and laboratory. Electric checking furnace is supplied for comparing standard and test couples. All listed in Catalog E-33A-503.



⅛ Actual Size

OPTICAL PYROMETER, potentiometer type, measures temperatures from 1400 to 5200 F. Available with two or three ranges. No charts or tables needed. Operator sights telescope on hot object, balances brightness of lamp filament against brightness of field, adjusts circuit to balance galvanometer, and reads temperature directly on the instrument's scale. Catalog N-33D.



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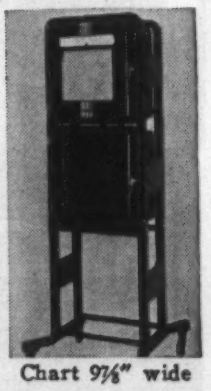

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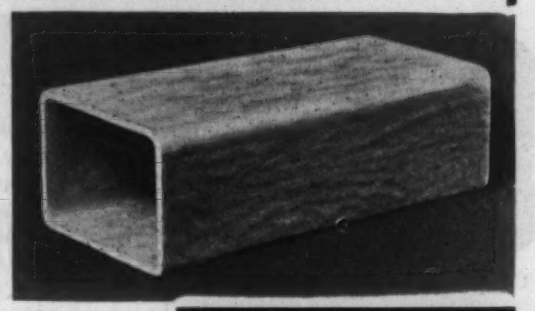

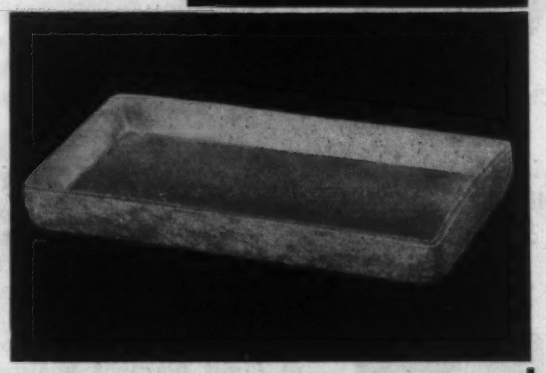

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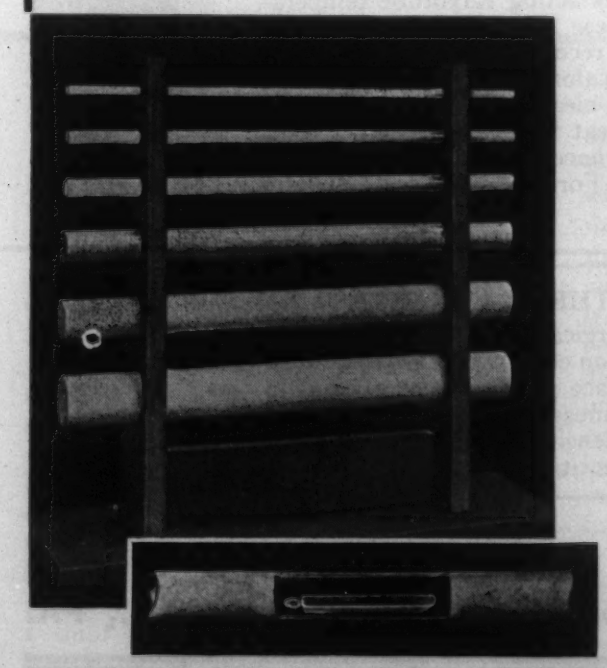

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15 min., the specimen is removed and the amount of iron in solution determined colorimetrically. The result is reported as milligrams of iron dissolved per square decimeters of surface, allowance being made for the area stopped off and including both sides of the plate.

The amount of iron going into solution varies from more than 4 mg. per sq. dm. with 2 oz. coatings to less than 0.1 with 2½-lb. coatings. When the iron dissolved is plotted versus the weight of coating in ounce per basis box on a logarithmic scale, almost a straight line is obtained for test results on both electro and hot dipped tin plate. This indicates that the amount of iron dissolved in the test is influenced mainly by the thickness of the coating and only slightly by the type of coating or the steel base.

Since this test gives an over-all figure for the quality of the tin coating but does not reveal the distribution of the discontinuities, it is recommended that it be combined with the modified hot water test for a more complete assessment of quality. After the thiocyanate test, the edges of the specimen may be de-waxed in trichlorethylene vapor and the specimen tested in the modified hot water test.

—R. Kerr, *Sheet Metal Inds.*, Vol. 17, May 1943, pp. 817-818; 825; June 1943, pp. 1001-1002; 1009

Radiography of Aircraft Castings

Condensed from "Metal Progress"

In February 1942, the Army Air Forces adopted a procedure for the X-ray examination of structural castings which would ensure that:

1—No casting which might fail would find its way into an airplane structure.

2—A minimum number of usable parts would be discarded by unnecessarily rigid inspection standards.

3—The inspection procedure be as economical of manpower and materials as was consistent with the first two aims.

Castings for use in hydraulic systems need not be X-rayed if they are hydrostatically tested unless sections of these castings are also subject to structural loads. In that case such sections are subject to the same requirements as structural castings.

Allowable Stress

Class B castings are those in which the ultimate design loads will not produce stresses in excess of 20 per cent of the allowable stress (10 per cent of minimum test bar strength) and may therefore be designed for no X-ray inspection. Class A castings, are designed so that the ultimate design loads produce stresses between 20 and 100 per cent of the allowable stress and must be radiographically examined and statically tested as follows:

Test Lot—The first 100 castings of the first production run of each Class A design must be 100 per cent X-ray inspected with special reference to stressed sections. The three worst castings are machined and tested to simulate the load of the castings as installed. If the weakest withstands a test load of 1.5 times the design load (1.25 for steel centrifugal castings), radiographs of the three become acceptable standards for all castings of the same design. If too weak, sounder castings are selected until satisfactory standards are obtained.

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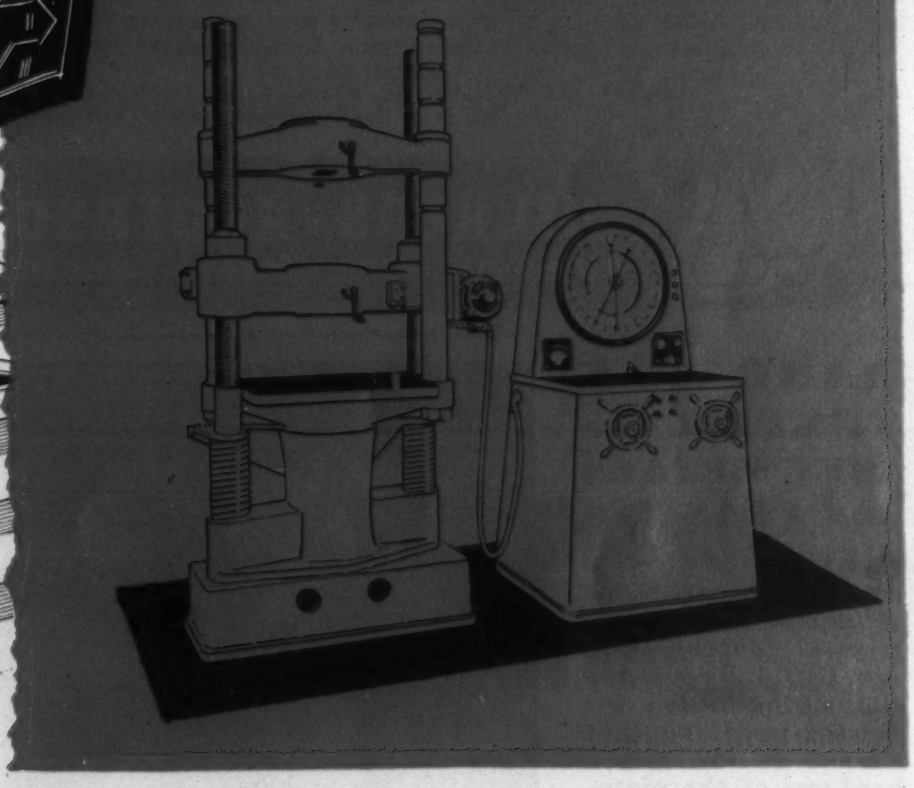

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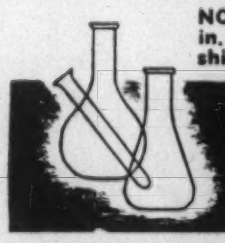

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Production Runs—Lots subsequent to the test lot are radiographically inspected on a percentage basis according to the ratio of test loads and design loads of the weakest of the test castings. Class A-1 castings, given 25 per cent inspection, are those where the ratio lies between 1.5 and 3.0 (1.25 and 3.0 for steel centrifugal castings). Class A-2, receiving 10 per cent inspection, are those in which the ratio of test lies between 3 and 10. Class A-3, with a ratio greater than 10, receives no X-ray inspection. When 1 per cent of the original sampling is found inferior to the standards, 100 per cent inspection of the balance may be required. Sub-standard A-1 castings are rejected, but sub-standard A-2 castings are placed in salvage as are castings whose defects cannot be judged from standard radiographs. Castings not receiving X-ray inspection are subject to visual inspection.

Radiographs

In addition to the requirements of static test, no Class A casting is acceptable with defects of a localized, stress raising type such as cracks, cold shuts, misruns and shrinkage voids. Defects of a general type, not stress raisers, are undesirable but are judged solely on the basis of the static test. These defects include gas porosity, blow-holes, segregation, microshrinkage, dross and sand inclusions, and mottling. General defects, so aligned as to cause stress concentration, are immediate cause for rejection.

Laboratories

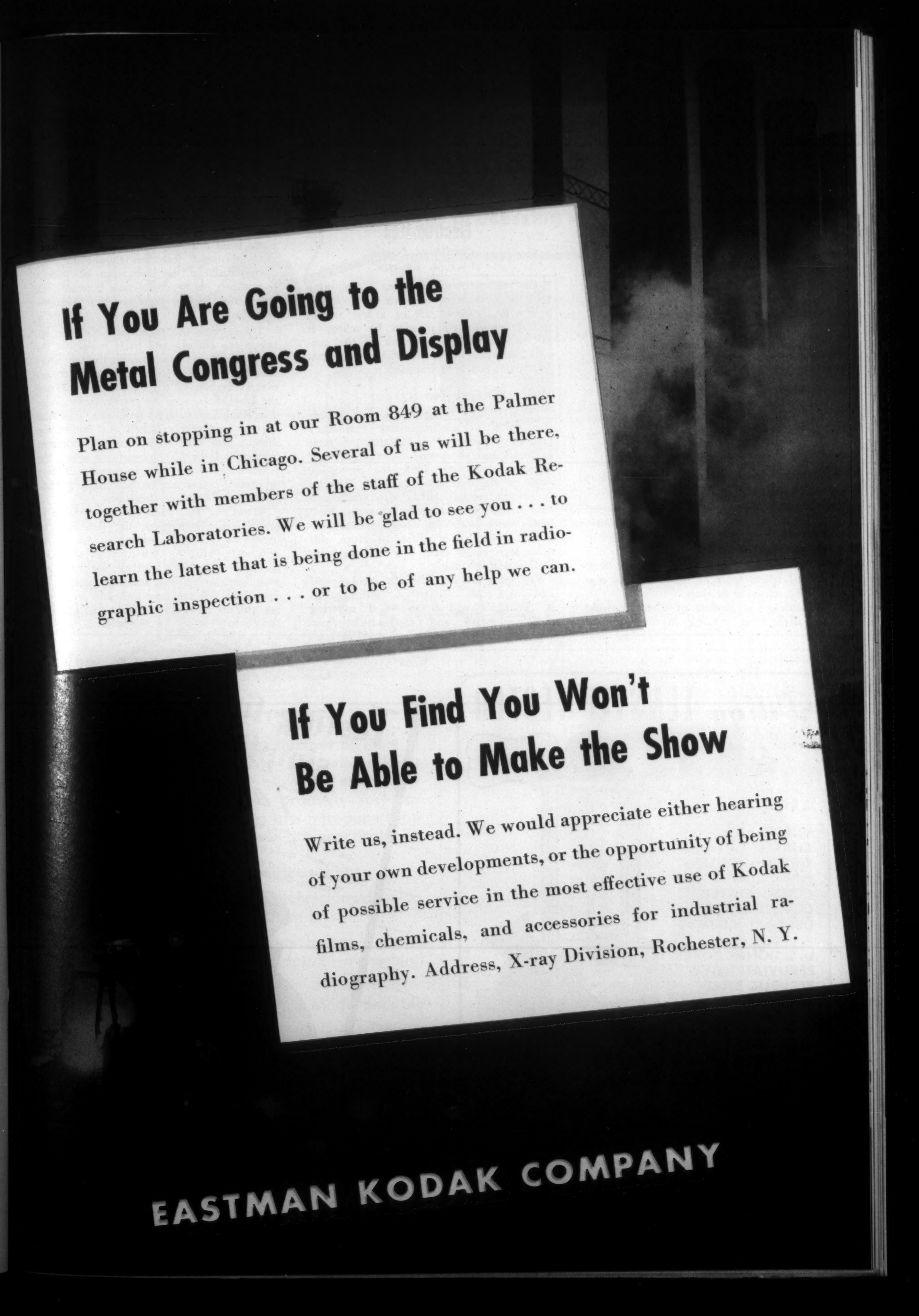
Certification of laboratories for the commercial radiography of Army aircraft castings is set up on the basis of a test which requires radiographs of six castings equal to radiographs previously prepared at Wright Field. About 40 laboratories have been approved. A laboratory failing at first may be retested. Certification may be withdrawn if radiography fails to meet requirements. The laboratory is simply certified to take X-ray pictures, not to accept or reject castings. Responsibility rests with the prime contractor and the laboratory may accept or reject for him only if authorized in writing and a copy of the document furnished the Army inspector.

Terminology

To avoid confusion in terms the following definitions of various discontinuities have been adopted:

Cracks: Darkened lines of variable width, dendritic when caused by hot shortness, and more nearly linear, or straight, and of more constant width, when from residual stresses in solid metal.

Shrinkage: Dendritic or filamentary dark regions of irregular dimensions and indistinct outline, caused by an insufficient supply of molten metal.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Cold Shuts: Darkened areas of variable length and smooth outline, tending to be elongated and thin, caused by failure of the streams of molten metal to weld together. They are usually detected by visual examination.

Misruns: Darkened areas of variable dimensions and smooth outlines, where the molten metal has failed to fill the sections, and usually seen by visual inspection.

Gas Porosity: A well distributed peppering of round or irregular dark spots, tending to be elongated or curved in coarse grained castings. This is generally found in aluminum alloy castings and is due to the presence of dissolved hydrogen.

Microshrinkage: Dark feathery streaks, or massive areas of definite outline, commonly in magnesium alloy castings and occasionally in others.

Blowholes: Well defined spherical or rounded darkened areas, caused by trapped air, mold or core gases, or water vapor.

Dross Inclusions: Small darkened regions of irregular or indistinct outline varying in intensity, tending to be random in occurrence but sometimes localized in the cope side.

Sand Inclusions: Gray spots of uneven granular texture with indistinct outline, random in occurrence but tending to concentrate near the drag side.

Segregation of Metallic Inclusions: Well defined white spots or mottled areas regular or irregular in shape.

Mottling: A pattern of alternate light and dark areas, tending to the size and shape of the macroscopic grains, due to the difference in chemical composition of the grain and grain boundary material; most frequently found in aluminum alloy castings.

—Robert Katz, *Metal Progress*, Vol. 44, July 1943, pp. 89-94.

The Salt Spray Test for Electroplates

Condensed from "A.S.T.M. Bulletin"

Government specifications containing salt spray test requirements have forced a greatly increased use of a test which, in the considered opinion of many, is of doubtful merit. Because of the general confusion, the production of important equipment has been impeded.

Uses of Salt Spray Test

Other things being equal, the protective value of electropositive (cathodic) metallic castings is a function of their thickness and an inverse function of their degree of porosity, while the protection value of electronegative (anodic) coatings is directly proportional to their thickness. The protective value of any coating, however, varies with its environmental conditions. To be of value, therefore, salt spray test results must be correlated with service performance.

Salt spray test requirements, incorporated into A.S.T.M. Tentative Specifications A 166-41 T and B 142-41 T covering nickel-chromium and copper-nickel-chromium on steel and zinc, respectively, prove that many consider the test of value for controlling the quality of those coating-basis combinations. In those cases the test is used to reveal the continuity of the coatings, known to be electropositive to the base metal in the presence of the salt solution. The corrodibility of the coating must be considered and in some cases the salt solution probably creates pores from relatively thin spots. Important in a laboratory test, this should not seriously handicap the indication of protective value, when correlation between salt spray and service behavior has been established.

The greater the potential difference between the coating and basis metal, in the particular environment within the salt spray chamber, the greater is the corrosive action at the site of the discontinuity. When the potentials are the same, only large discontinuities will be revealed. The test is not particularly suited for comparing directly the relative porosity of different coating-basis metal combinations unless the potential relations are the same. It may be useful for comparing the relative porosities of the same combinations.

When the potentials are reversed, as in electronegative coatings, the test may be useful as a rough measure of the thickness or quantity of the coating but other methods (Magnetic Method for nonmagnetic coatings on iron and steel and Dropping Tests for zinc and cadmium on steel) are quicker and more reliable. With zinc, but not with cadmium, the relation between

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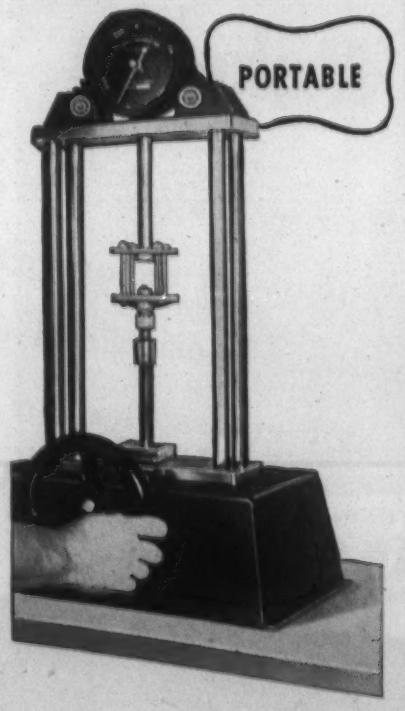

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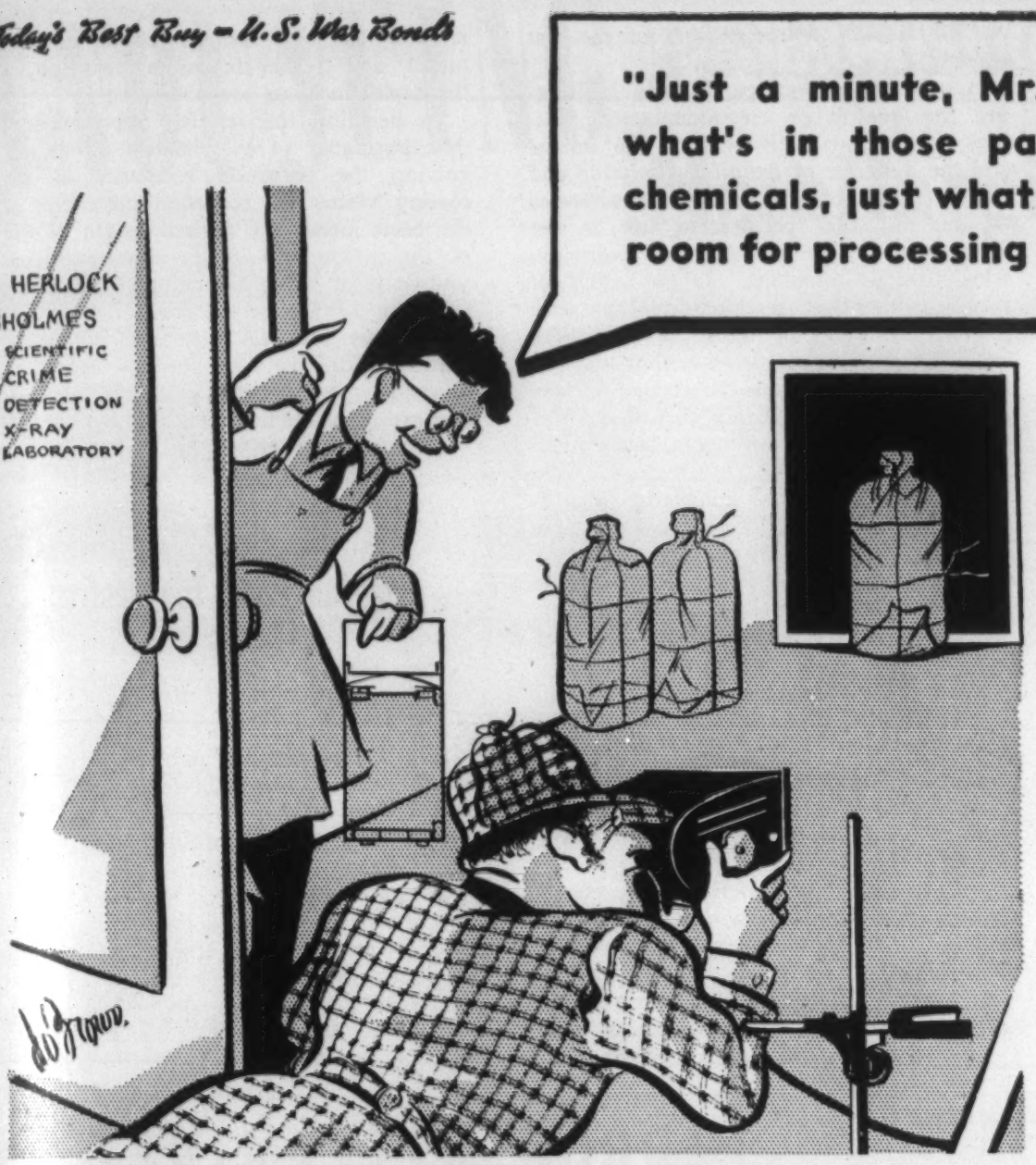

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thickness of the coating and its salt spray life seems to be a straightline function. Again the test may be misleading for comparing different coating-basis metal combinations.

The test can be used to check deleterious effects of coupling dissimilar metals and the effectiveness of electrodeposited coatings in minimizing such action. Correlation with actual exposure should be established because the potential relationship may change depending on environment, and a strong electrolyte is present in the salt spray test to promote galvanic action.

In judging the corrodibility of the coating itself, which must be considered, for example, in finishes for sensitive electrical and mechanical equipment the test may be useful. Correlation with service performance is important as the test provides continuous wetting and atmospheric exposure is intermittent.

Limitations

Current methods of prescribing and conducting the test vary widely. Solutions and concentrations range from natural and synthetic sea water to saturated sodium chloride. Temperatures vary from uncontrolled "room temperature" to 150 deg. F. Air pressures, to atomize the solution, range from 8 to 80 lbs. per sq. in. Test chambers vary from those the size of a small room to those of a few cubic feet. Positions of the specimens vary from horizontal to vertical and exposure periods range from 1 to 500 hrs. This accounts for the lack of reproducibility of the test results.

Another limitation, particularly in judging the quality of electrodeposited coatings, is the qualitativeness of the results and the difficulty of defining a suitable end point. One of the greatest weaknesses of the test for specification use is the problem of describing a degree of corrosion which can be tolerated. In the A.S.T.M. specifications this is circumvented with reasonable success by requiring that there be no appreciable corrosion within a specified time. Appreciable is defined as the presence of more than six corrosion spots per square foot, or any spots larger than 1/16 in. in diam.

Lack of fundamental knowledge regarding the behavior of different coating base metal combinations, particularly the magnitude of the potential relationship between the two metals, is another limitation. Any correlation with service behavior can only be established with certainty by actual test of each combination.

Requirements for Tests in Specifications

Before incorporating tests for acceptance or rejection, in a specification, it should be established that the test is reproducible and that there is suitable correlation between test results and service performance. Good correlation has been reported between salt spray and outdoor exposure tests of nickel coatings on steel. Increased corrosion protection in both cases is obtained by increasing the thickness (decreasing the porosity) of the coating. Correlation has not been satisfactory when nickel and nickel-chromium coatings of the same thickness are compared.

In deciding the relative importance of the appearance of the finished article, involving the corrosion resistance of the coating versus the corrosion protection of the basis metal, the desired length of life of the article and its environmental conditions must be considered. Literal interpretation of the requirements often does not convey the real intent of the specification. Definite knowledge regarding minimum requirements and care in defining the end point of the test are needed.

—C. H. Sample. Preprint No. 32, June 1943 meeting, A.S.T.M. Bulletin.

Aluminum Under the Electron Microscope

Condensed from "Aluminium"

Rolled, recrystallized and cast aluminum of 99.99 and 99.5 per cent purity and hydronalium (Al with 9 per cent Mg) were etched with a solution of 30 cc. H_2O, 30 cc. concentrated HCl, 20 cc. concentrated HNO_3 and 5 cc. concentrated HF, after finely grinding the surface. After rinsing and drying, the pieces were anodically oxidized for 3 min. in an electrolyte of 2.5 per cent ammonium borate solution at 19 to 20 deg. C. (66 to 68 deg. F.) and 50 v.

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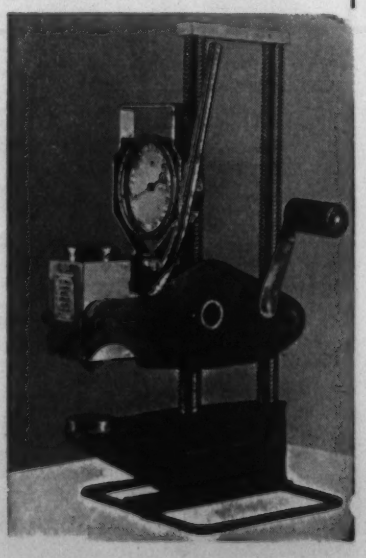

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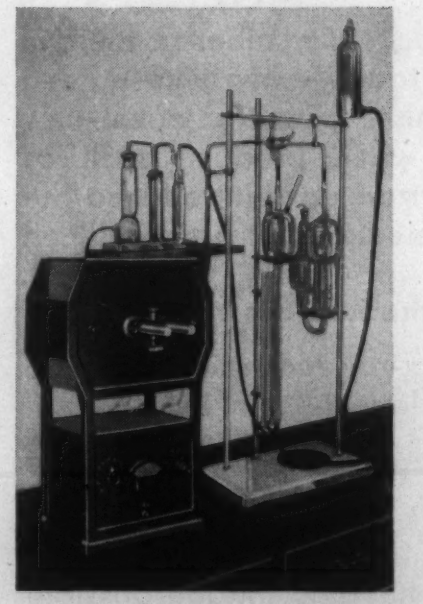

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The thin film of Al_2O_3 formed on the surface was removed (by the mercury method) and cleaned in diluted HCl. It gives a true replica of the deep-etched metallic surface which then, on an object slide, is examined in the electron microscope. The characteristic structures of the 3 states of treatment of the samples show up very plastically and in fine perspective. The purest aluminum has well-formed cubes that become somewhat less distinct in 99.5 per cent Al, very likely due to the impurities. Hydronalium has still more rounded-off corners of the cubes due to the greater amount of the alloying element.

—Edith Semmler, *Aluminium*, Vol. 24, Sept. 1942, pp. 302-307.

Hardness Testing Aluminum Alloys

Condensed from "Aluminium"

The experiments were made with hard and soft aluminum of 99.4 and 99.99 per cent purity, hard duralumin DM 31, semihard and soft duranalium MG 3, hard and soft polital. Brinell and Vickers hardness generally decrease with decreasing thickness of the piece as the material flows away on the underside; for thin sheets the Vickers test only should be applied.

The practical minimum thickness is, for a hardness above 100 kg. per sq. mm., 0.3D; for 50 to 100 kg. per sq. mm., 0.5D, and below 50 kg. per sq. mm., 0.8D, where D is the diam. of the sphere in the Brinell test. The limit for the Vickers test is given by $s = 1.2d$, where d is the average diagonal of the impression, and s is the smallest permissible thickness. The least distance between Brinell impressions, as well as the least distance from the edge, is given by $a = 2d$, where a is the distance and d is as before.

With regard to duration of load, it was found to depend not on hardness but on the composition of the material. Two groups were distinguished: While purest and pure aluminum and aluminum-manganese alloys showed decreasing values of hardness even after 13 hrs., all other alloys gave correct values already after 3 sec. In practice, the time of loading should be at least 30 sec. for the former group and 10 sec. is sufficient for the other. The tests are described in full.

—E. V. Rajakovics and H. O. Maier, *Aluminium*, Vol. 24, Oct. 1942, pp. 347-354.

Surface Roughness Test

Condensed from "Foundry Trade Journal"

From time to time descriptions of an optical method of obtaining a profile curve of a surface have appeared, but the details of the actual system have been meagre and sometimes misleading. The method was apparently devised by Schmaltz or Epenstein.

The author's apparatus is a Vickers projection microscope, with a suitable addition to the illuminating system and with a subsidiary stage to hold the sample whose surface is being examined. The illuminating system is so arranged that it is possible to focus the image of a straight edge on the surface under examination. A stainless steel safety razor blade is used to provide the straight edge, and is carried in the filter holder and is illuminated from the rear by a "Point-o-Lite" lamp and lens system supplied with the microscope.

For work at magnifications between approximately 20 and 300 a 2/3 in. objective is used to produce the image of the straight edge. The sample whose surface is being examined is placed on the holder which inclines its surface at an angle of 45 deg. both to the axis of the illuminating system and to the axis of the microscope.

The outstanding characteristic of this method of determining surface roughness is that it is non-destructive. Not only is it applicable to machined and ground surfaces, but also to "as cast" and fractured surfaces. Furthermore, it is not limited to reflecting surfaces, but may be applied to surfaces in general, including sand-blasted surfaces, the surfaces of molds and cores, the surfaces of abrasive wheels, and even to textiles.

—J. F. Kayser, *Foundry Trade J.*, Vol. 70, June 17, 1943, pp. 137, 138.

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Welding Light Metals Under Helium

Both manual and automatic arc-welding equipment for magnesium, aluminum and their alloys under a protective shield of helium gas have been developed by *General Electric Co.*, Schenectady. It makes a smooth clean weld at rates up to 40 in. per min. on ⅛ in. stock.

In the accompanying photograph, the filler metal (magnesium here) is unreeled into the work at the correct angle through the small nozzle rod at the lower left.

The tungsten electrode used to start and maintain the arc extends through the center of the rod that is perpendicular to the work, and the helium gas is fed in around the electrode.

The rate of filler metal feed can be adjusted to a constant uniform feed into the arc, or a supplementary control can feed wire into the arc, withdraw it, then feed it in again — all on a predetermined cycle. The heart of the manual equipment is a specially-designed electrode holder that accommodates either a tungsten or carbon electrode to conduct the welding current to the electrode and to surround the electrode with helium gas.

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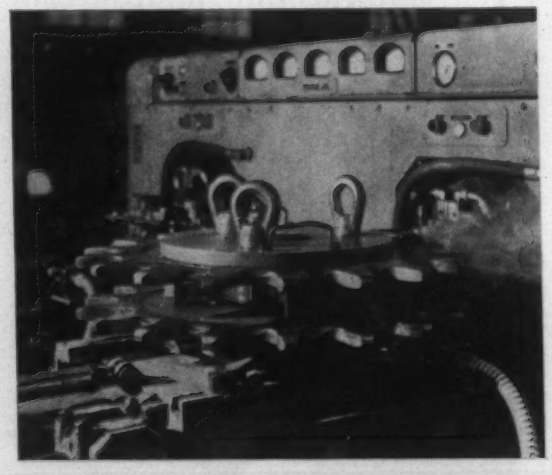
Fixture for Induction Hardening

The hardening of 36 large sprocket teeth in less time than former methods took to harden 18 is now done by *International Harvester Co.* through use of a novel automatic fixture installed on a new Tocco induction hardening machine. The hardening speed has been increased 133 per cent.

The automatic fixture holds two sprockets pancakewise, hardening two teeth simultaneously. At the stroke of a hydraulic plunger the fixture advances, introducing the teeth to the water-cooled inductor. After the hardening cycle, the fixture withdraws the sprockets, indexes and advances again to the inductor. Operation is entirely automatic.

The heating cycle consists of a 10-sec. heat, 4-sec. quench and 6-sec. index for a total of 20 secs. per 2 teeth. Teeth are 2¼ in. deep, 1¼ in. wide at the base and ⅝ in. at the top. A hardness of Rockwell 51-58 "C" is confined to the top and pitch line of the tooth, with depth not in excess of 5/32 to 3/16 in.



The accompanying photo reveals the automatic fixture and jig for holding two sprockets for half-trac combat vehicles. It was designed by the *Ohio Crankshaft Co.*, 3800 Harvard Ave., Cleveland 1.

● A Jeep "scrap hound" performs two services: Picks up ferrous scrap from factory floors and saves thousands of dollars in cut and punctured tires. Designed by conservation engineers of *Willys-Overland Motors*, Toledo, Ohio, the Jeep magnet added 3,145 lbs. of nails, steel turnings, etc. during the first four days of operation. It consists of a standard 4-cylinder Jeep motor, generator, magnet able to lift 700 lbs., and a Jeep trailer.

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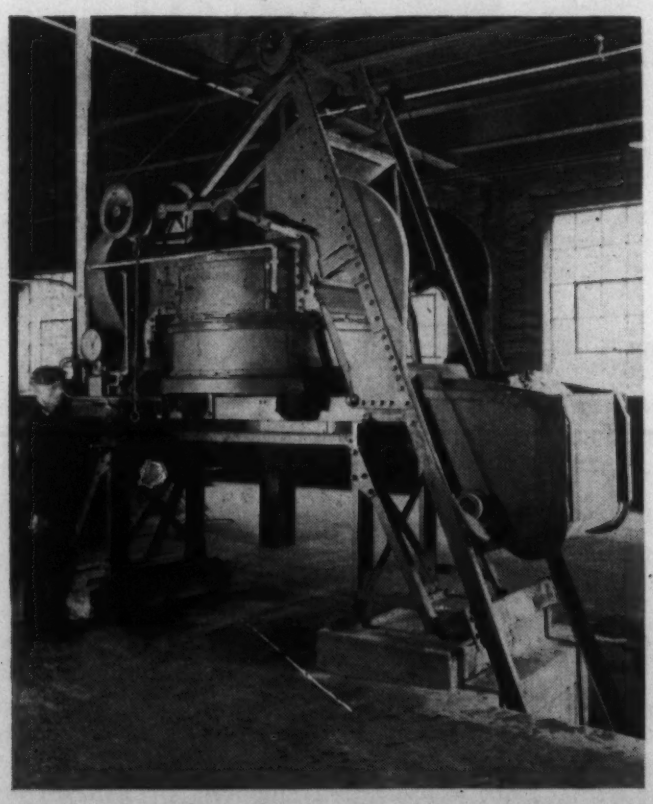

"Lancaster" Mixer, Symbol EAG-4 closed pan type, fitted with dust cover and full batch elevator hopper.

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Fluorescent Daylighted Magnifier

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tors, which swivel freely so that it will not tip over.

The accompanying photo represents the single lens instrument, but a double lens instrument is also available. The lens is 5 in. double convex, and the head may be adjusted easily to any angle.

For shops and offices they come in maroon color; for first aid departments, in white. They are made by *Larrimore Sales Co.*, P. O. Box 1234, St. Louis 1.

● Safety booths for grinding and polishing operations are a feature in the New Jersey plants of the *Propeller Div., Curtiss-Wright Corp.* They are air-conditioned to carry off harmful dust particles, cut down noisy grinding operations and eliminate hazards from flying pieces of metal. They are built of Thermax. A fan in the rear carries off dust and small metal particles while larger pieces of steel are thrown into a salvage hopper below. Passing workers are protected from flying particles by a baffle.

Arc Welding Positioners

A newly-designed line of arc welding positioners features the dual capacity rating of each model. Put out by the *Harnischfeger Corp.*, Milwaukee 14, the WP-6, in the 6000-lb. class, handles loads up to 6000 lbs. maximum and has a secondary capacity of 9000 lbs. Standard models are being produced in dual capacities up to 24,000 lbs.

Construction is for constant heavy-duty service, using all-welded rolled steel throughout, with strong box-type mounting. Table-top areas are larger than usual, and there is greater clearance for handling large weldments. A self-locking worm gear and spindle drive on tilting motion prevent upsets.

A limit switch and adjustable stop brackets give additional safety. Table turning is by a pinion from a totally inclosed flood-lubricated gear case to a bull gear, to which the table-top is bolted securely.

One Compact

LEPEL UNIT

does them all faster, better more economically

HARDENING

Heat localized exactly where wanted at any desired temperature up to 5000° F. Ideal for gears, cams, bearing surfaces, cutting tools and other areas subject to wear.

ANNEALING

STRESS RELIEVING

NORMALIZING

PREHEATING

for Forging, Drawing, etc.

—multiplying production while maintaining a degree of precision and accuracy rarely attainable by other methods.

Simple, dependable and clean in operation. Often operated entirely by women.

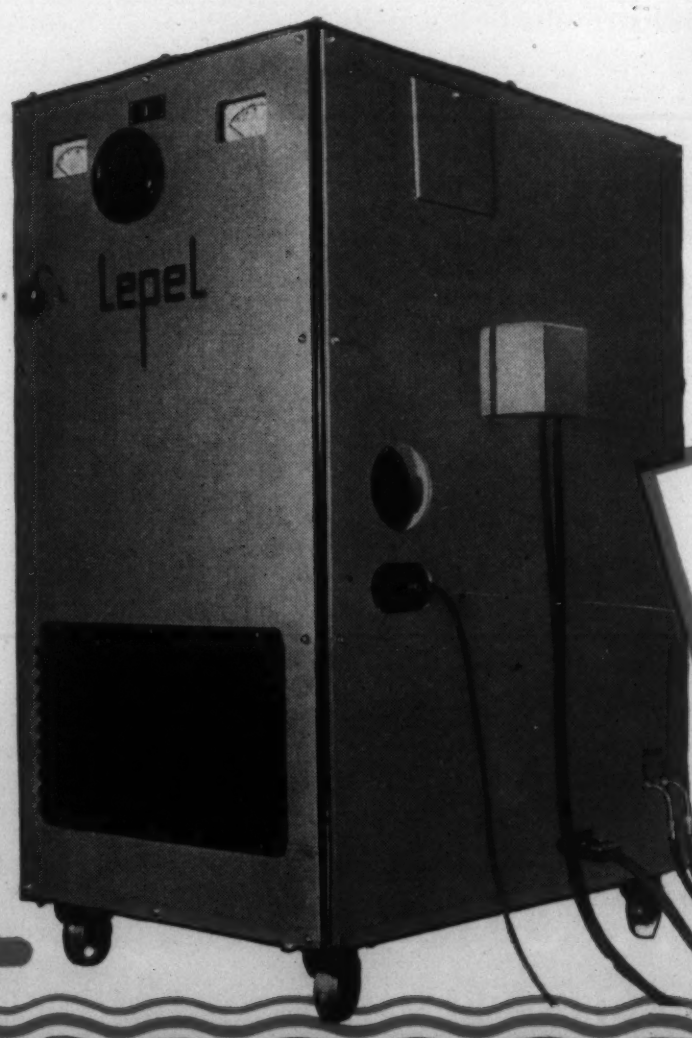
Relatively inexpensive, easily movable and readily adaptable to peace-time production without any conversion whatever.

Send samples and specifications of your work for complete engineering data and recommendations. Ask for catalog.

LEPEL HIGH FREQUENCY LABORATORIES

Pioneers in Induction Heating

39 WEST 60th STREET • NEW YORK 23, N. Y.

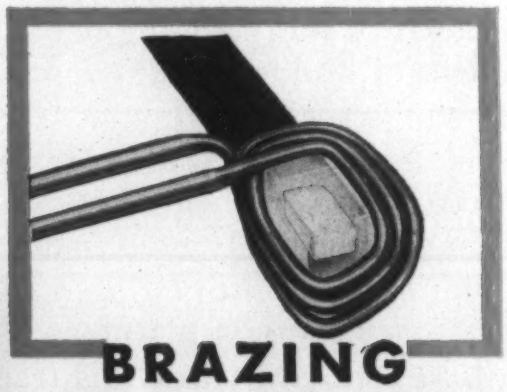


MELTING

Readily melts metals and alloys of high melting point.

SOLDERING

Neater, faster, without waste. Less scale and discoloration.



BRAZING

Permits widest choice of copper or silver brazing alloys from lowest to highest melting points. Ideal for brazing carbide tips.

See the Lepel Unit in Operation

Room 738, Palmer House
Chicago
National Metal Congress
and War Conference Display
October 18-22

Lepel

HIGH FREQUENCY INDUCTION HEATING UNITS

ZINC PLATING

TURCO

TYPE X POROKLEEN PENETROL

Working in co-operation with industry, Turco research chemists and field engineers have solved the plating problems of hundreds of war production plants. The data thus compiled have been summarized in a comprehensive bulletin.

"CYANIDE ZINC AND BRIGHT ZINC PLATING"

Turco offers this bulletin as a free service to industry. It describes materials, equipment and the practicable technique required in most plating operations where it is necessary to replace cadmium plating with zinc plating.

A limited edition of this free bulletin is now available to engineering and production executives. Use the coupon below or make request on your letterhead.

A consultation with your nearest Turco Field Service Man, who will prescribe the material and equipment you need, merely awaits your request.

TURCO PRODUCTS, INC.

SPECIALIZED INDUSTRIAL CHEMICAL COMPOUNDS

MAIN OFFICE & FACTORY: 6135 SO. CENTRAL AVE., LOS ANGELES 54
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SERVICE MEN AND WAREHOUSE STOCKS IN ALL PRINCIPAL CITIES

3rd WAR LOAN BACK THE ATTACK

TURCO PRODUCTS, INC., 6135 S. Central Ave., Los Angeles 54

Please send free bulletin, "CYANIDE ZINC & BRIGHT ZINC PLATING"

Name..... *Firm*.....

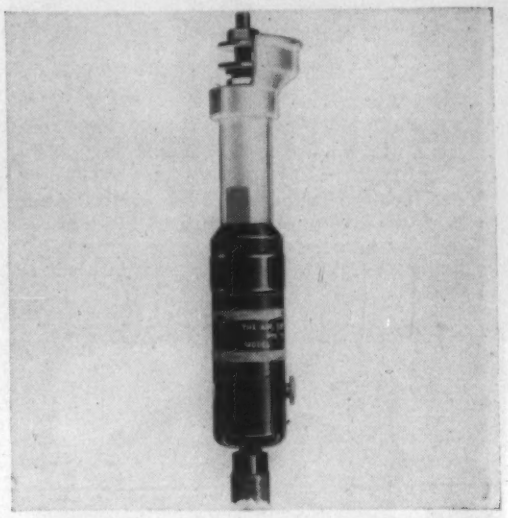
Title.....

Address.....

ON YOUR LETTERHEAD, PLEASE 28-103

Pneumatic Foundry Grinders

Two new portable pneumatic production grinders for 2-in. wheel grinding and cleaning of castings are announced by *Aro Equipment Corp.*, Bryan, Ohio. They are excellent for use with rotary file burrs on aluminum and magnesium. They weigh



about 4 lbs. and have an adjustable speed control of 15,000 to 18,000 r.p.m.

Model 221 has a button throttle control, and Model 321 a lever throttle. They have malleable motor housings and malleable throttle heads, and are available with a variety of adapters, collets and extensions.

Huge Mechanical Trimming Press

One of the largest mechanical trimming presses ever built was recently shipped from the *Toledo Div., E. W. Bliss Co.*, Brooklyn 23, New York. It can trim forgings coming from a hammer of 33,000 lbs. capacity. Operating at 5 strokes per min., the machine is triple-geared with twin drive on the crankshaft. A 4-piece tie-rod frame construction was employed.

Weighing 450,000 lbs., the multiple disc flywheel type air friction clutch and brake with electric push-button control are features.

Magnetic Polishing Lathe

A polishing lathe has been designed with special purpose of holding odd shapes of steel for polishing, burring or lapping. Put out by the *Lima Electric Motor Co.*, 3601 Findlay Road, Lima, Ohio, this Lima magnetic polishing lathe holds parts from 1½ in. diameter up. It leaves no chuck or collet marks.

A foot-pedal control magnetizes the chuck, starts the motor, stops the motor and demagnetizes the chuck, leaving the operator free to handle and process the work. A swinging table attached to the pedestal, which can be raised or lowered to accommodate different diameter chucks, holds the parts to be processed, being easily adjustable.

It is furnished with single or 2-speed motors; 2- or 3-phase, with motor speeds to 3000 r.p.m. There are interchangeable face plates and register plugs. It can be supplied in either pedestal or bench type.

What's Behind the Trade Mark?

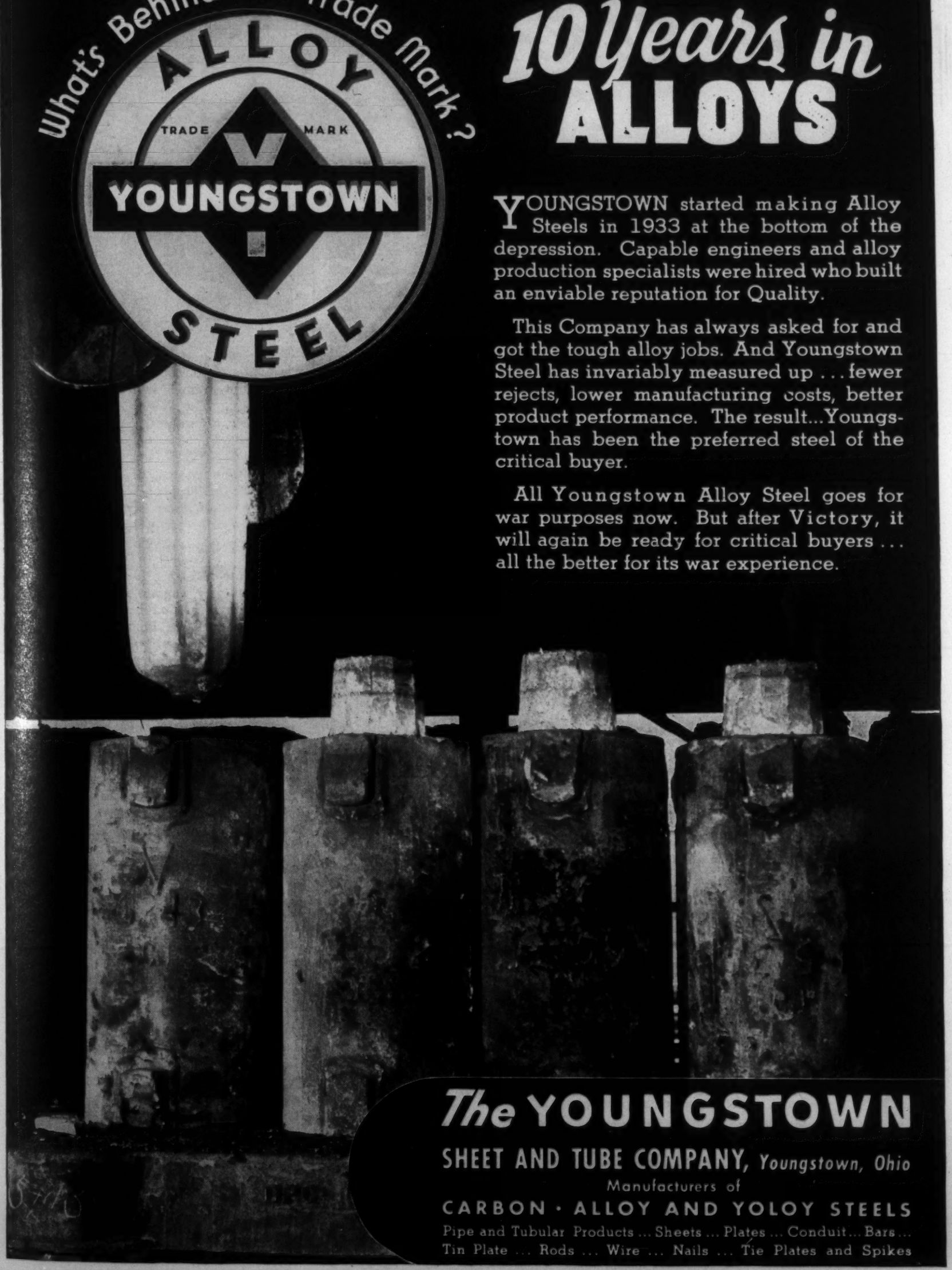
ALLOY TRADE MARK V YOUNGSTOWN STEEL

10 Years in ALLOYS

YOUNGSTOWN started making Alloy Steels in 1933 at the bottom of the depression. Capable engineers and alloy production specialists were hired who built an enviable reputation for Quality.

This Company has always asked for and got the tough alloy jobs. And Youngstown Steel has invariably measured up . . . fewer rejects, lower manufacturing costs, better product performance. The result...Youngstown has been the preferred steel of the critical buyer.

All Youngstown Alloy Steel goes for war purposes now. But after Victory, it will again be ready for critical buyers . . . all the better for its war experience.



The YOUNGSTOWN
SHEET AND TUBE COMPANY, *Youngstown, Ohio*
Manufacturers of
CARBON · ALLOY AND YOLOY STEELS
Pipe and Tubular Products ... Sheets ... Plates ... Conduit ... Bars ... Tin Plate ... Rods ... Wire ... Nails ... Tie Plates and Spikes

★

ANDREWS

AIRCRAFT

STEEL

Flashing across the sky like meteors, American devastators strike with the speed and destruction of a thousand lightning bolts. Into the construction of these streaks of lightning goes the finest steel produced . . . steel that must meet exacting specifications. We are proud that we have a part in the manufacture of the kind of steel that makes American planes the finest in the world. Available in a wide range of thicknesses, widths and lengths, our aircraft quality alloy and carbon steel sheets meet specifications AN-QQ-S-685 (X-4130). AN-QQ-S-686 (X-4135). AN-QQ-S-756 (X-4340). AN-S-11 (SAE 1020-1025). AN-S-12 (NE-8630). AN-S-22 (NE-8635). Complete details will be sent on request.

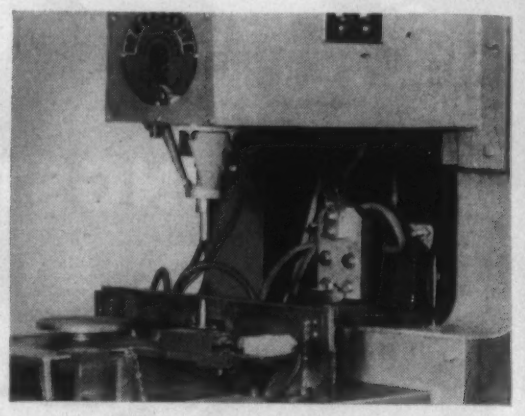
THE NEWPORT ROLLING MILL CO.
NEWPORT KENTUCKY
DIVISION OF THE ANDREWS STEEL CO.

The Andrews Steel Company produces a limited range of aircraft quality alloy plates.

Resistance Welding Adapted to Riveting

Riveting of stamped assemblies can be accomplished on an ingenious adaptation of equipment originally developed for resistance welding. Developed by the *Progressive Welder Co.*, 737 Piquette Ave., Detroit, it looks like a spot welder.

Equipped with an indexing table, it hot-



upsets and rivets in place the vanes of hydraulic flywheels. Ends of the vanes stick through holes in the faces of assembly rings. The "electrodes" are brought down under pressure against them, heating and upsetting these ends to rivet the parts securely.

The right amount of heat is obtained with conventional welding timers combined with a lower current density than would be used for welding.

● Because resistance furnace temperatures are apt to vary, engineers of *Westinghouse Electric & Mfg. Co.*, East Pittsburgh, Pa. have developed the Furnatron control system to keep such variations to a minimum. It is done by combining a suitable thermocouple type of temperature controller with automatic electronic control of the saturation current of a saturable reactor connected in the supply line of the furnace elements, thus automatically controlling the power input into the furnace. It works on a single or 3-phase furnace. Where necessary, an anode transformer is furnished. It includes a compensator for line voltage variations.

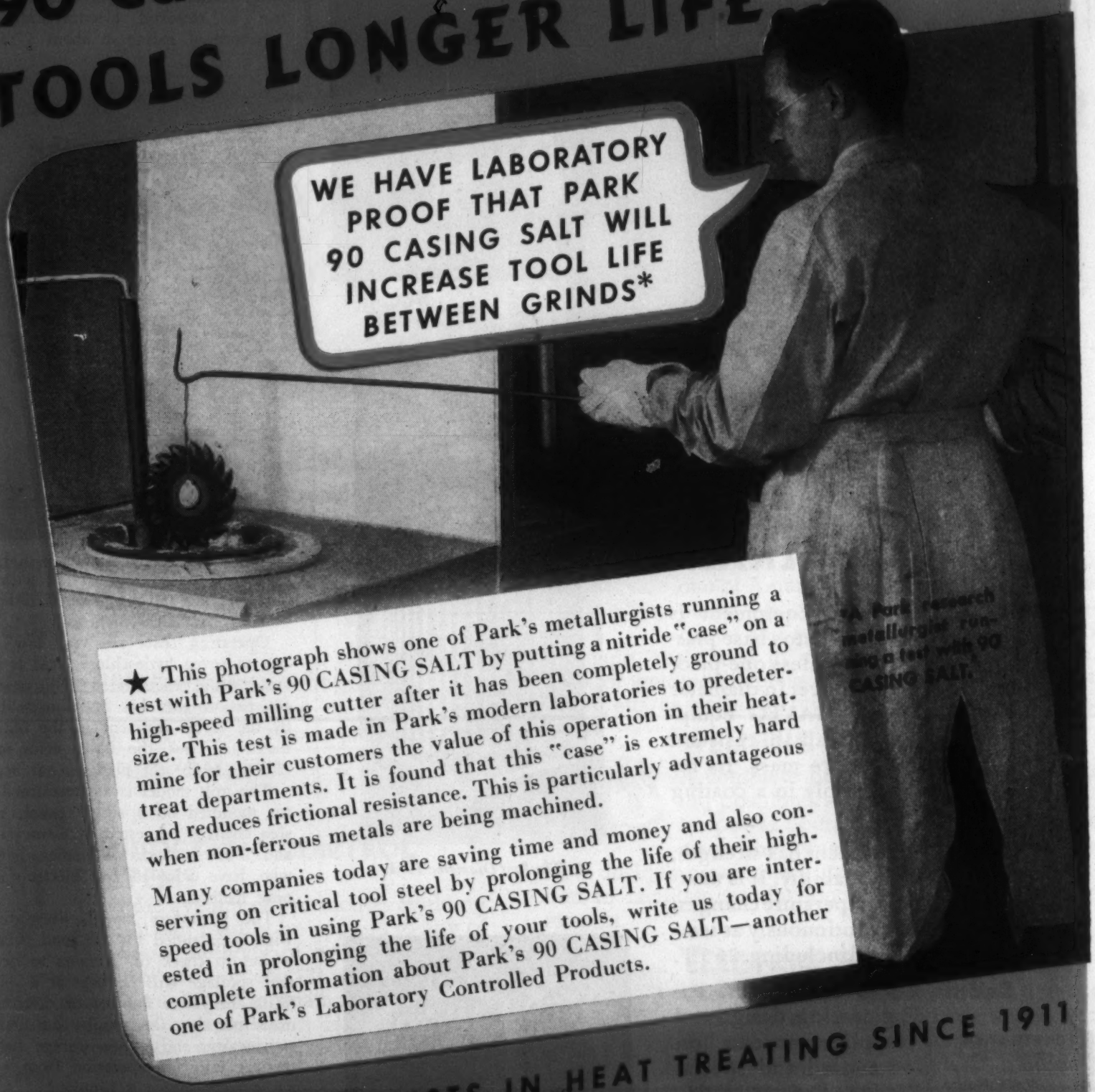
New Heat Exchanger for Oils, etc.

For adding heat to industrial liquids to maintain constant temperatures, with automatic control, a patent has been granted on a new Aero heat exchanger, made by *Niagara Blower Co.*, 6 E. 45th St., New York 17. This has not been done previously with the evaporative type liquid cooling unit using a water spray and fans to draw air over coils containing the liquid whose temperature is to be controlled. This is accomplished by using either a steam coil or injector or an electric heating unit to heat the spray water.

The heating device is put into operation by thermostatic control at the desired point, preventing the liquid from becoming too cold or viscous, or from congealing or freezing. It can be installed outdoors. It is useful for metal quenching baths, cutting oils and lubricants, machine and wire drawing, etc.

Park

90 Casing Salt GIVES YOUR TOOLS LONGER LIFE



★ This photograph shows one of Park's metallurgists running a test with Park's 90 CASING SALT by putting a nitride "case" on a high-speed milling cutter after it has been completely ground to size. This test is made in Park's modern laboratories to predetermine for their customers the value of this operation in their heat-treat departments. It is found that this "case" is extremely hard and reduces frictional resistance. This is particularly advantageous when non-ferrous metals are being machined.

Many companies today are saving time and money and also conserving on critical tool steel by prolonging the life of their high-speed tools in using Park's 90 CASING SALT. If you are interested in prolonging the life of your tools, write us today for complete information about Park's 90 CASING SALT—another one of Park's Laboratory Controlled Products.

★ SPECIALISTS IN HEAT TREATING SINCE 1911

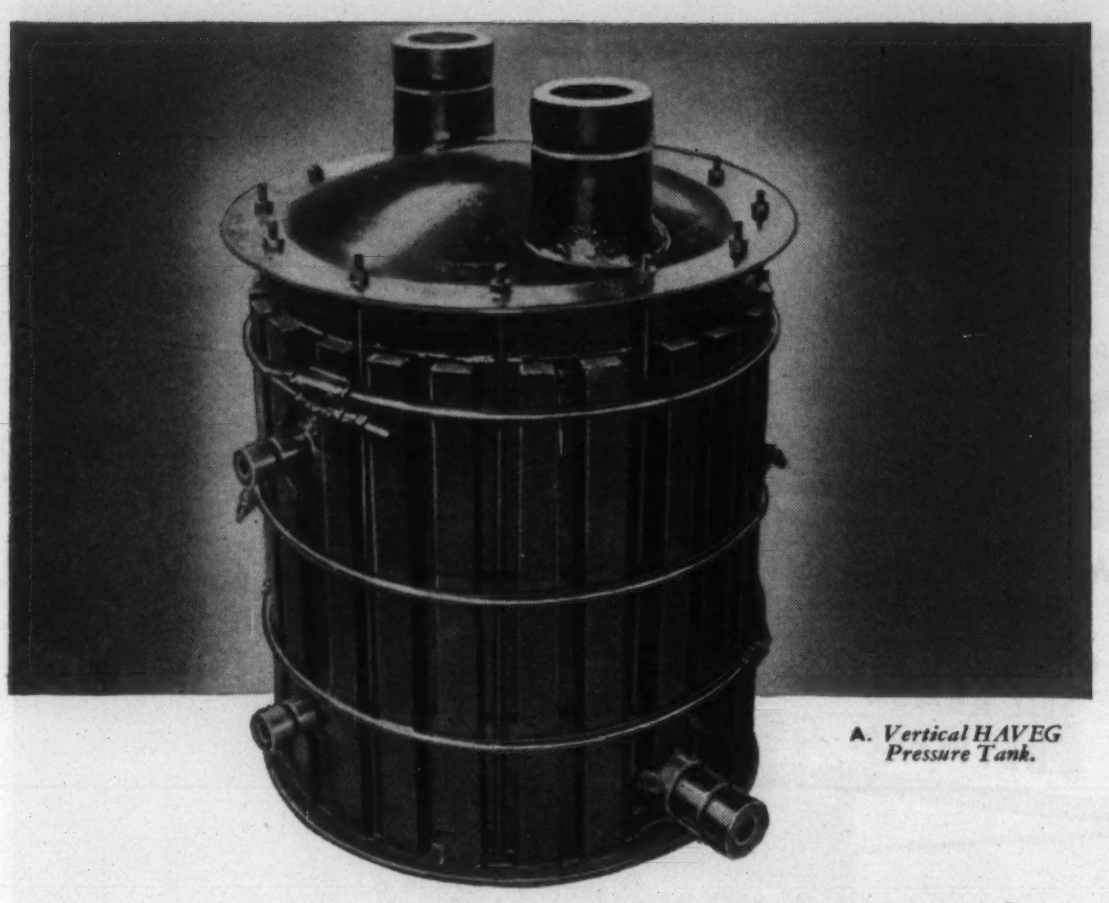
Park

PARK CHEMICAL CO.

DETROIT MICHIGAN

● Liquid and Solid Carburizers ☆ Cyanide, Neutral and High Speed Steel Salts ☆ Lead Pot Carbon ☆ Charcoal ☆ Coke ☆ No Carb. ☆ Carbon Preventer ☆ Quenching and Tempering Oils ☆ Drawing Salts ☆ Metal Cleaners ☆ Liquid Grain Cement

8078 MILITARY AVE. DETROIT, MICH.



A. *Vertical HAVEG Pressure Tank.*

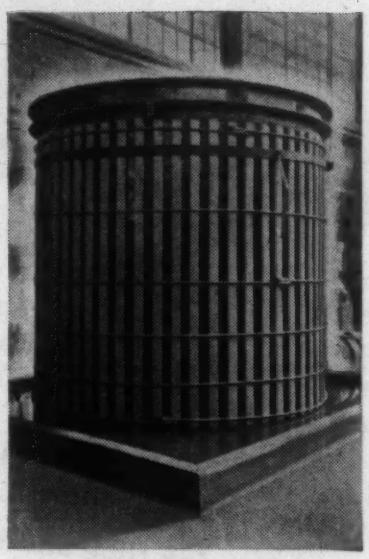
HAVEG RESISTS ACIDS AND ALKALIES

HAVEG Chemical Equipment is molded from an asbestos base plastic. It is made in seamless one-piece units as large as 10 feet in diameter by 12 feet high. HAVEG Equipment is acid and alkali resistant throughout its entire mass. Its resistance is not simply in a coating or lining.

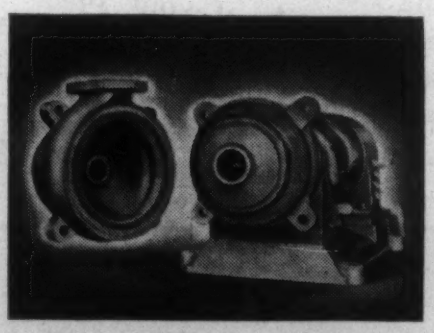
HAVEG Equipment has strength, toughness and durability. It is unaffected by rapid temperature changes. It may be used continuously at temperatures up to and including, 265°F.

Bulletin F-3 gives complete engineering, design and application data on standard and special types of HAVEG equipment, pipe, valves and fittings. Send for a copy today.

HAVEG-SARAN Tubing; Pipe & Fittings; and sheets are available from stock. HAVEG-SARAN is also described in Bulletin F-3. Send for a copy now.



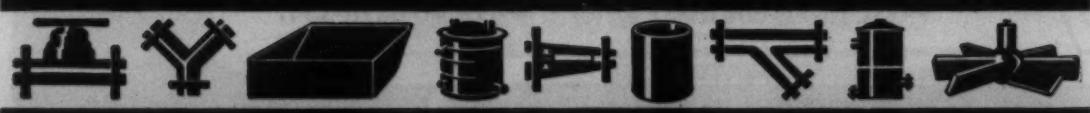
B. *Ten Foot Diameter Tank.*



C. *Wilfley HAVEG Pump.*

HK-43

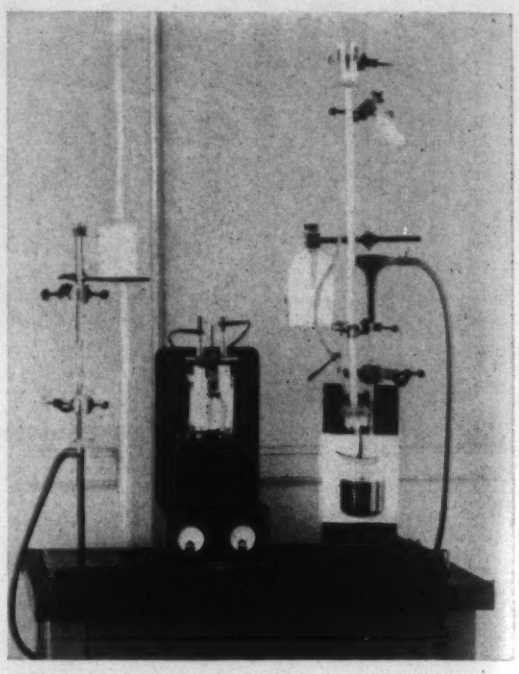
HAVEG CORPORATION
NEWARK, DELAWARE
FACTORY–MARSHALLTON, DELAWARE



CLEVELAND 550 Leader Building
CHICAGO 1201 Palmolive Building
DETROIT 2832 E. Grand Blvd.
LOS ANGELES 601 W. Fifth St.

Apparatus for Tin Coating Determination

For the determination of tin coating, the Bendix "Electro-Stripper" has been made available by *Wilkens-Anderson Co.*, 111 N. Canal St., Chicago. With the Bendix, one operator may handle 200 determinations per day, eliminating the older tedious stripping of the tin from plate with concentrated hydrochloric acid. The tin is removed electrolytically in the presence of iodine in about 1 min. The



excess iodine is back-titrated with sodium thiosulphate, and the method is applicable to heavy and light coatings.

Operating costs are very low, as only one to seven hydrochloric acid is used instead of the concentrated. This new method for tin weights has been made necessary by the errors inherent in the old Seller's method. Thus, the .05-lb. error in testing .25 to .50-lb. tin plate is not acceptable.

The mill model is a streamlined apparatus mounted on a single panel, with design changes suggested by *Carnegie-Illinois* and *Weirton Steel* companies, and others who have adopted the electrolytic stripping method.

The laboratory model, illustrated herewith, is intended for the food packer who wishes to check tin weights to be certain that spoilage will be kept at a minimum. With the fewer number of determinations made per day, the simpler units are quite satisfactory, and either storage battery or rectifier unit for operation from 110 volt a.c. current source is supplied.

Combination Saw and File

Called a "saw gun," a new hand instrument "saws and files where no other tool can reach," stakes the maker, *Mid-States Equipment Co.*, 2427 S. Michigan Ave., Chicago. It works on several materials, including stainless steel, Monel metal, castings and rods.

Propelled by electric power, compressed air or flexible shaft, it provides an efficient portable power-saw or file. In sawing, a broken hack-saw blade is used for ordinary work. Filing is performed by inserting "almost any file." There are six models.

P&H

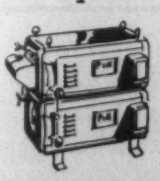
AMERICA'S ONLY MANUFACTURER PROVIDING A COMPLETE WELDING SERVICE

Here, under one roof, the builder of welding equipment is also one of the world's largest users. Pioneers in production welding, P&H has always led the way with new methods and techniques as well as in designing for the welded fabrication.

The new P&H Production Welding Control System will be demonstrated at the Metal Show, Room 813, Palmer House, Chicago, Oct. 18-22, 1943.

PRODUCTION CONTROL SYSTEMS

The P&H system of Production Welding Control can readily be applied to any of the basic methods of compensation to gain accurate control of (1) costs, (2) procedures, (3) production and (4) quality. Originated by P&H and used by other large companies, it is the practical solution to production welding control. Literature on request.

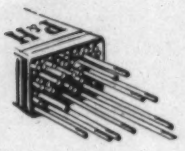


D.C. ARC WELDERS

All with single control and the new "Visi-matic" calibration plate. All P&H arc welders are rated on the WSR (Welding Service Range) basis, which tells you the exact amount of usable welding current, from minimum to maximum, for each machine. Capacities up to 600 amperes.

A.C. ARC WELDERS

A new series of industrial machines (for both intermittent and heavy duty service) with a wide range of capacities. All models provide the continuous, concentrated arc which is so easy to control. The complete line includes models from 20 to 1200-ampere capacity based on WSR ratings.



WELDING ELECTRODES

Produced under rigid quality control in one of America's most modern electrode plants. All sizes and types for maintenance and repair work such as for hard surfacing, resistance to impact, wear, and abrasion. Also for welding stainless, 4-6% chrome steels, armor plates, etc., as well as all types of mild steel electrodes.

WELDING POSITIONERS

A complete line of dual capacity welding positioners up to 24,000 lbs. capacity; power operated for handling various sizes and types of welded structures. New designs provide the utmost simplicity of operation to facilitate production welding. Literature on request.

ELECTRIC HOISTS

Used in welderies everywhere for the handling of steel, sub-assemblies, etc. All capacities up to 15 tons are made in three series of hoists which provide a variety of mountings to suit every need for lifting, lowering, or horizontal travel. Literature on request.

OVERHEAD CRANES

P&H is America's largest builder of overhead cranes. Whether for heavy duty or for intermittent service, P&H builds a size and type exactly suited for each requirement. You can count on P&H's honest delivery dates.

General Offices:

4550 West National Avenue, Milwaukee 14, Wisconsin

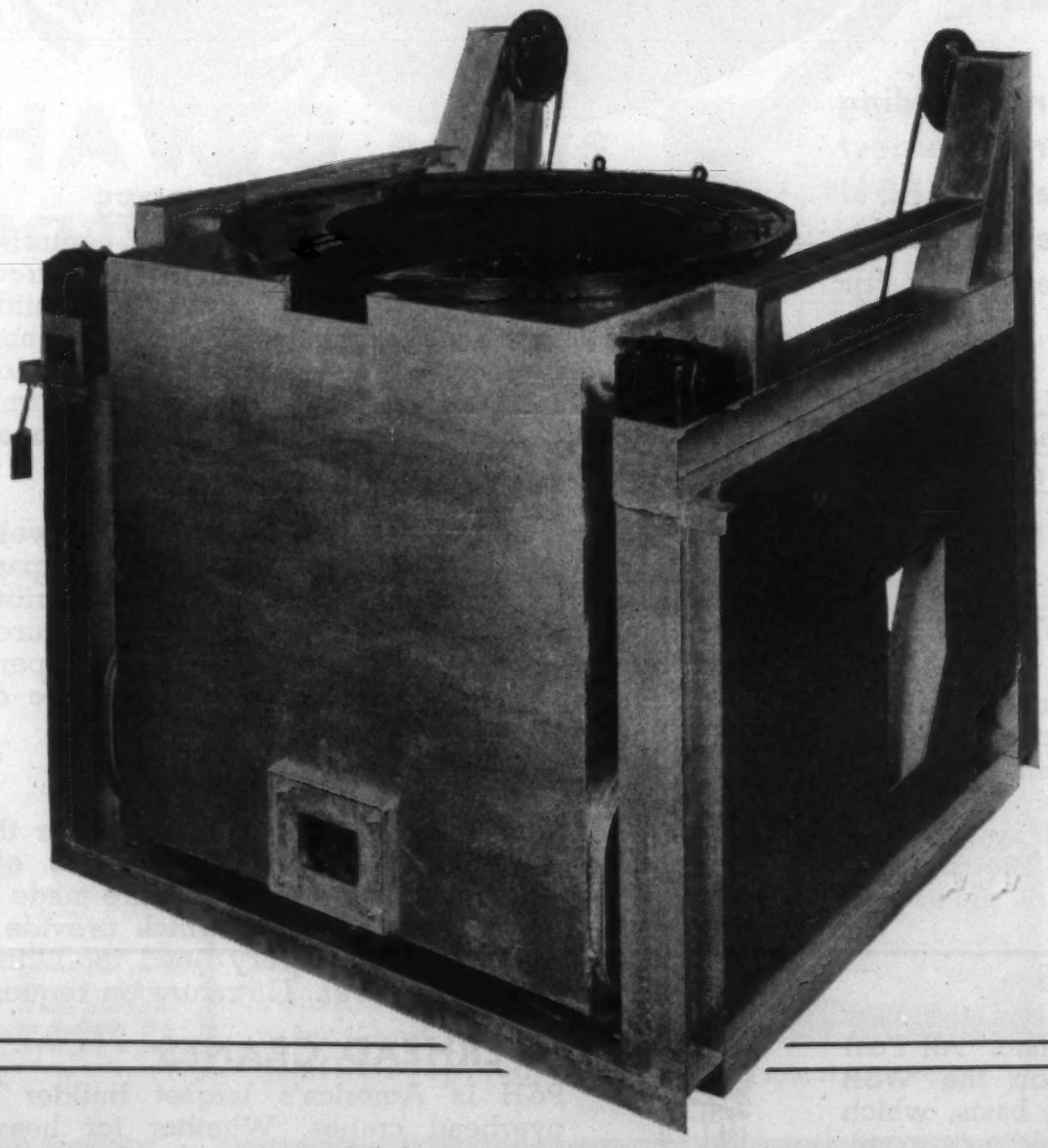
HARNISCHFEGER CORPORATION

ARC WELDERS • EXCAVATORS • ELECTRIC CRANES P&H MOTORS • HOISTS • WELDING ELECTRODES

MONARCH FURNACES

for Magnesium *and* Aluminum

- *MOTORIZED NOSE POUR*
- *HAND TILTING*
- *STATIONARY*

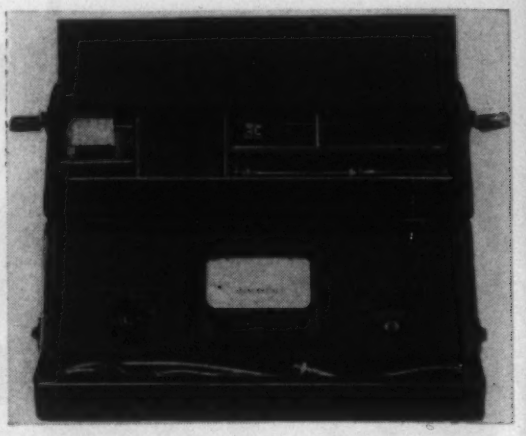


THE MONARCH ENGINEERING AND MANUFACTURING CO.

Curtis Bay Baltimore, Md.

Instrument for Measuring Surface Roughness

A new profilometer, for providing extremely accurate measurements of surface roughness by direct dial readings, is much lighter and smaller than other such instruments. Known as Type Q, it is made by *Physicists Research Co.*, 343 S. Main St., Ann Arbor, Mich.



The meter panel is now set at a 45 deg. angle, thus permitting the operator to remain seated, where formerly he had to stand. In the calibration of tracers they are now all adjusted to the same calibration number so that adjustment of the amplifier in the field is no longer required.

It may be used on 115 or 230 volt 50-60 cycle power lines. By simply moving a tracer, either manually or automatically, over surfaces of practically any size, shape or degree of roughness, the information is indicated in true inch units on the dial. No computations or other scaling methods are necessary.

The photograph shows the convenient compartments that hold the tracer, Flex-arm and glass specimen.

● A new film solution which will bring out details in X-ray films that are not noticeable to the naked eye is announced by *St. John X-ray Service, Inc.*, 30-20 Thomson Ave., Long Island City, N. Y. It is of special importance in X-ray diffraction analysis where lines must be measured by an optical device. In evaluation of back-reflection patterns 1/1000 in. corresponds to 2000 p.s.i. in residual stress. If the lines are not sharply defined, the results would be inaccurate.

Universal Ball Joint Vise

The Strickland universal ball joint vise is designed for holding chip breakers, curlers and cutting tools while grinding at predetermined angles. Manufactured by the *Wall-Colmonoy Corp.*, 720 Fisher Bldg., Detroit, the principle is that by matching the ball joint vertical degree graduation with the horizontal degree graduation required, settings are instantly and accurately obtained. A single movement of a clamp wrench locks the vise rigidly.

The range is a 30 deg. arc through the horizontal plane. The vise is 5¼ in. wide, 4¾ in. high, with ball and socket protected by an adjustable leather dust apron.

THERMONIC

The Most Efficient and Economical System for Induction Heating

IT IS OUR HOPE that by extending this as an informal come-one-come-all invitation, we will turn Room 860* into a clinic of questions and answers on Induction Heating in general and Thermonic in particular! This new method of heat treating has contributed greatly to the war effort – has speeded up production on the industrial front and has solved many a tough manufacturing problem. Because the *National Metal Congress* gives us the opportunity for get-together discussions, we are arranging for the attendance of Thermonic's complete staff . . . Messrs. Edward S. Goodridge, Leo Edelson, J. Wesley Cable, W. C. Rudd, Ray Wile, Nat Levin, John H. Garger, Harris B. Carlock, Floyd C. White . . . All will be on hand to make your visit well worth while.

Palmer House, Chicago, Oct. 18-22

INDUCTION HEATING CORPORATION

Largest Producers of Electronic Heat Treating Equipment for

brazing
melting
surface hardening
forging
annealing

389 LAFAYETTE STREET, NEW YORK 3, N. Y.

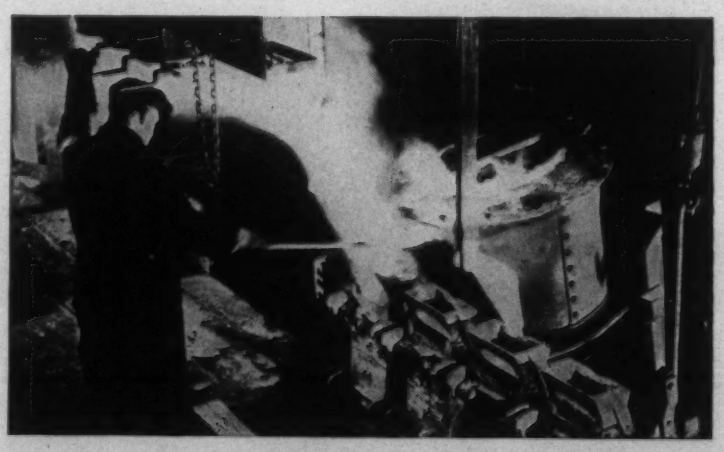
Model 140 Positioner maneuvering a heavy, awkward load so that top, bottom and sides are easily accessible for downhand welding. This is accomplished with just one set-up, greatly reducing overhead crane service time.

C-F Positioners cut welding time as much as 60%, reduce handling time to a fraction, assure uniformly stronger, smoother welds, and greatly increase output per man. With C-F POSITIONERS you can not only speed-up today's war production, but will be tooled-up to meet after-the-war competition, because each C-F POSITIONER is a *universal tool* — is pedestal mounted to give maximum clearance from all sides, is adjustable for height, rotates 360° and tilts to 135° beyond horizontal . . . gives "a thousand different set-ups" at the push of a button or turn of a hand wheel. Six types, capacities to 30,000 pounds manually operated, motor driven or with variable speed drive for hand or automatic welding.

Write for Bulletin WP 22.

CULLEN-FRIESTEDT CO.
1314 S. Kilbourn Ave.
CHICAGO, ILLINOIS

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL



No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS" — the magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia, Pa.

*HUNDREDS OF MILLIONS OF POUNDS ANNUALLY

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORPORATION, Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC COMPANY, INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ENGINEERING CORPORATION, Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

Copper Rings Cast Centrifugally

Copper rings for certain electrical apparatus are cast centrifugally at *General Electric's Schenectady Works.* This assures better quality than in sand casting, reduces the amount of scrap, eliminates sand holes and blow holes, and provides a much denser metal.

Copper is brought to a temperature of between 1200 and 1250 deg. C., or 100

deg. higher than that needed for sand casting. The runner box and die are heated with torches to 250 deg. C. After the drosses are skimmed from the surface, the molten copper is poured into the runner box, whence it flows into the spinning die.

When more than one crucible is used, the opening between the runner box and the die is plugged long enough to prevent any interruption between the charges, thus avoiding the possibility of a cold shot. The die is spun at 300 r.p.m. for 2 mins. After the casting is removed, impurities in the rings inside are taken out by machining.

In the accompanying photograph is the rotating die, which will accommodate 1000-lb. castings.

● A special line of inspectors' stamps for Magnaflux work is announced by *New Method Steel Stamps, Inc.,* 147 Jos. Campau St., Detroit 7. A feature is the incorporation of the letters, MF, together with the numeral or letter within a specially shaped border.

Improved Rocker Arm Welder

An improved rocker arm welder designed for condenser-discharge welding of aluminum sheet is announced by *Progressive Welder Co.,* Detroit 12. There is a relationship between machine rigidity and frequency with which points have to be dressed; hence, the new "Model B" requires fewer point dressings in a day's run than other types now in use.

It is designed to handle any combination of two thicknesses of 24-ST Alclad, between 0.016 and 0.081 in., at overall production rates of between 1000 and 2000 spots per hr., including point dressing time, etc. Refrigerated electrodes, insulated piping, etc. are optional.

N-A-X High Tensile

welds readily...

into High Strength Weldments for ordnance equipment

It was no mere chance that manufacturers of Army Ordnance materiel selected N-A-X HIGH TENSILE for parts for gun mounts, Jeeps and Tanks and other pieces of equipment. Long before the war N-A-X HIGH TENSILE had won unqualified approval of both fabricator and user, because this high strength steel was easy to form, draw and weld. N-A-X HIGH TENSILE, the really superior low alloy steel, does not air harden. It fuses and mixes with the weld metal readily, easily . . . and can be readily welded by any of the commercial processes.

N-A-X HIGH TENSILE also has great resistance to impact and fatigue in both extremely hot or sub-zero temperatures. It has unusually high ductility, high yield point, high ultimate strength and marked resistance to corrosion and abrasion—properties that make for speedier fabrication and longer life.

Full information is available on N-A-X HIGH TENSILE. Write today for your copy of a new booklet describing the properties and characteristics of N-A-X HIGH TENSILE . . . the truly versatile low alloy steel.

GREAT LAKES STEEL CORPORATION

Detroit, Michigan

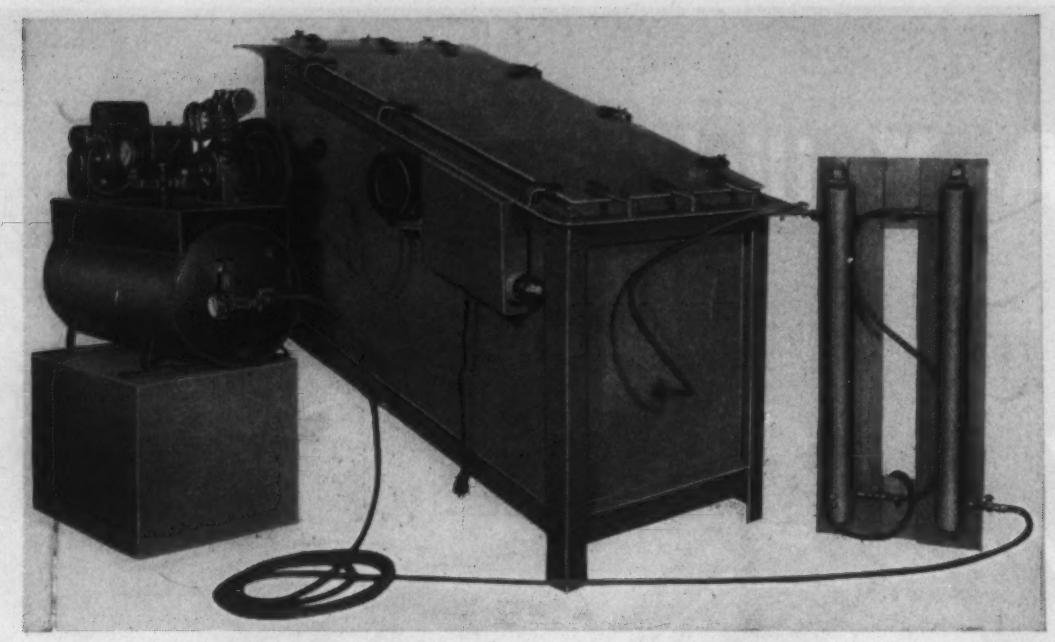
Sales Offices in Principal Cities

NATIONAL STEEL

Division of

NATIONAL STEEL CORPORATION

Executive Offices · Pittsburgh, Pa.



The **MUNNING SALT SPRAY TEST EQUIPMENT**

for determining Resistance to Corrosion

The salt spray method is the most practical for ascertaining the value of electro deposited articles by testing for corrosive resistance of the base metal and permeability of the plated coating.

This Munning Improved Model shown above conforms to army, navy and aeronautical specifications, and is recommended for producing accelerated corrosion tests to simulate service behavior.

Let us give you further details. Write or 'phone.

MUNNING & MUNNING Inc.

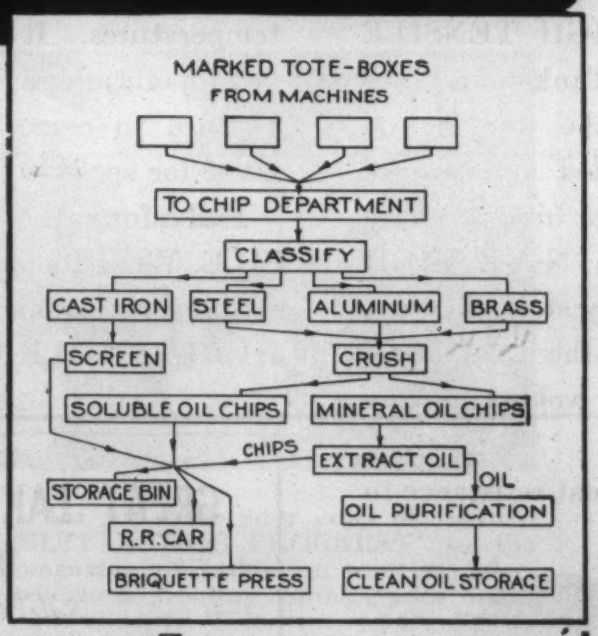
Engineers • Designers • Manufacturers

Main Office and Factory: 202-208 Emmett St., Newark, N. J.

NEW YORK — PHILADELPHIA — WOONSOCKET, R. I.

Modern Chip Handling

We specialize in the analysis of chip-handling problems and the design and installation of equipment putting metal scrap reclamation on an efficient, profitable basis. Our Chipveyor Systems are proving helpful in solving chip handling and chip segregation problems in many large industrial plants.

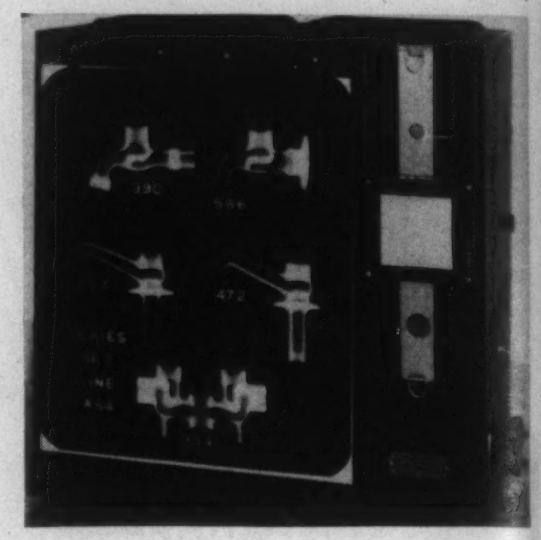


NATIONAL CHIPVEYOR SYSTEMS

50 CHURCH STREET
NEW YORK 7, N. Y.

High Intensity X-Ray Illuminator

A new high intensity industrial X-ray illuminator, which provides four times more illumination than heretofore available, is announced by *Kelley-Koett Mfg. Co.,* Covington, Ky. It permits observation of film detail formerly missed with



weaker light sources. It raises the usable density of films from 1.5 to more than 4.0.

A Variac control can vary voltage from 0 to 110 volts, providing the exact amount of light necessary to observe details at various film densities. The illuminator is 14 by 17 in., with masks used when films are smaller. A wet film hanger allows observation immediately after development.

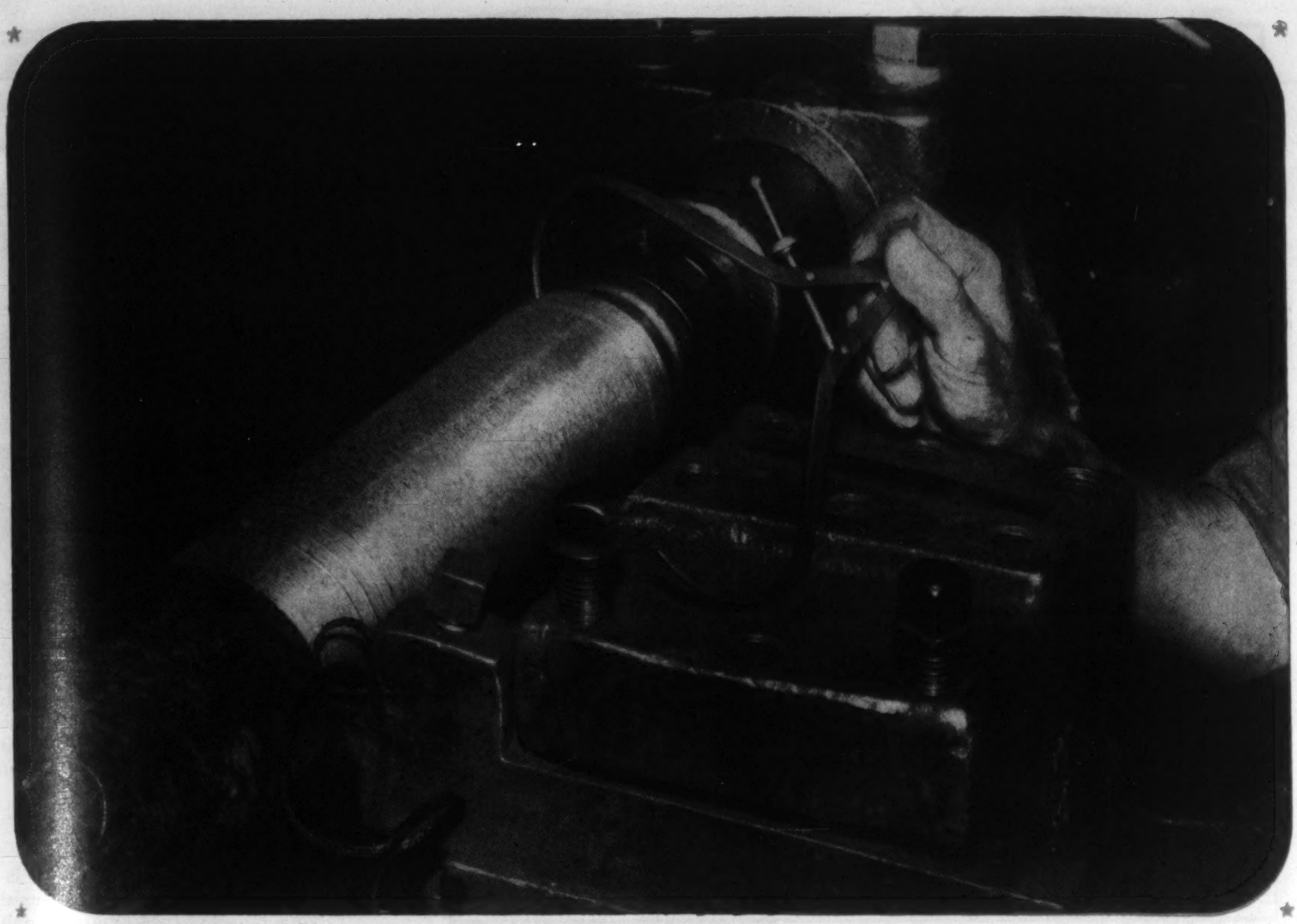
A glass baffle and cooling fans circulating 900 cu. ft. of air per min. dissipate all excess heat. A 3-in. spot with 4 times the intensity of the large front surface allows examination of critical areas.

● By plating airplane piston rings with .005 in. of chromium on the cylinder contacting surface, our fighting aircraft have been able to fly five times as many hours between engine overhauls, even in Africa where the abrasive dust of the desert has no ceiling, states *American Hammered Piston Ring Div.,* Koppers Co., Baltimore. The chrome on airplane rings is not the dense, bright plating used on automobile bumpers, but "Porus-Krome," gentle on cylinder walls, permits lubrication and resisting wear.

Simple, Compact X-Ray

"Searchray" is a simple compact X-ray, both fluoroscopic and radiographic in action, which provides a quick simple means for the non-destructive internal inspection of small parts, molds, castings of light alloys, ceramics, plastics, rubber, etc. It is made by *North American Philips Co., Inc.,* 419 Fourth Ave., New York.

No elaborate tools are needed; there is no intricate system of dials or controls to adjust. The operator plugs into a 110 volt power supply, places the object in the compartment, closes the door and presses the button. The object can be seen instantly fluoroscopically through the eye-level eyepiece. Weighing about 425 lbs., it takes up less than 5 sq. ft. of floor space.



DBL High Speed Steel HAS SET RECORDS
. . . NOW HERE'S *Super DBL!*

DEVELOPED ESPECIALLY FOR YOUR HEAVY-CUT FAST-FEED, HARD AND *Tough Jobs!*

THIS is the next step in Allegheny Ludlum metallurgical development of the DBL low-tungsten molybdenum analysis. *Super DBL* is the DBL analysis with the addition of cobalt, and it develops the maximum red hardness—the same *extra margin* of cutting quality—that you were formerly accustomed to get in a tungsten cobalt steel as compared to 18-4-1.

Super DBL has been thoroughly tested and proved. In performance, as well as in the conservation of vital alloys, it meets the needs of the times. You'll find it an ideal selection for heavy duty tools—especially suited for roughing or hogging work on hard, gritty materials, such as cast iron and steel; or on tough materials like heat treated alloy and stainless steels. There is nothing special in its heat treating or handling requirements. ● Available *now*—in standard forms and finishes, and in mill-treated toolholder bits—from Allegheny Ludlum and distributor's warehouse stocks, coast to coast.

STEEL FOR THE NATION'S WELFARE

Allegheny Ludlum
STEEL CORPORATION
BRACKENRIDGE, PENNSYLVANIA

A-9073 . . . W & D

The following equipment is available for immediate delivery:

LEITZ Metallographic microscope (upright type) with Panopak for bright and darkfield, binocular observation tube, camera, etc.

LEITZ Large Micro Metallograph with horizontal camera on optical bench

ZEISS Metalscope with Epicondenser W

LEITZ-BLOSJO Carbonmeter (Made in U.S.A.)

LEITZ G & D Electro Titrator

B & L Model FSM Metallurgical Microscopes with camera

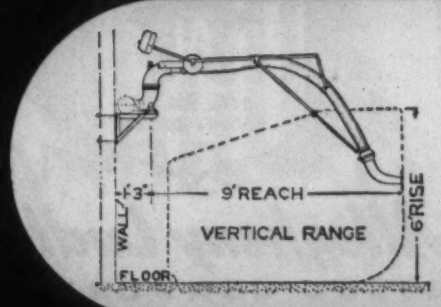
SPENCER No. 63 Metallurgical Microscopes with and without camera

Photomicrographic and MACRO cameras

For details write to:

Gamma Instrument Co., Inc.

95 Madison Ave. New York 16, N. Y.



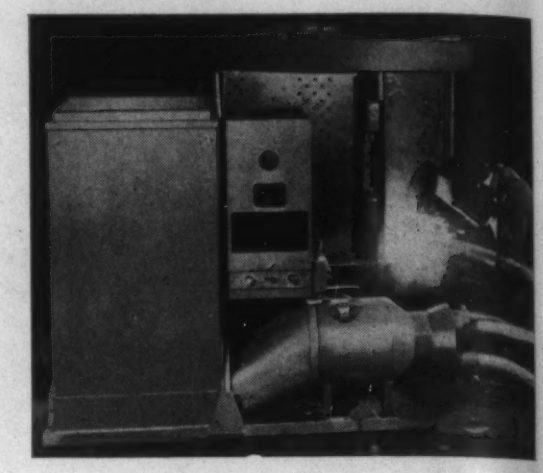
GUARD EMPLOYEE HEALTH by installing Ruemelin Fume Collectors wherever welding operations take place. They remove noxious gases, heat and smoke at the source . . . eliminate employee fatigue . . . speed up welding operations. Built in 3 foot, 9 foot and 15 foot sizes. Hundreds in operation all over the country. Write for bulletin No. 37-C.

RUEMELIN MFG. CO.,
3894 N. Palmer St., Milwaukee 12, Wis.

RUEMELIN FUME COLLECTOR

Welding Fumes Removed by Electronics

Electronics is now applied to the removal of welding fumes. A portable *Westinghouse* Precipitron electrostatic air cleaning unit with three flexible metal



hoses can be moved to any plant welding location.

Drawn through the hoses, the fumes pass through the air cleaner, where 90 per cent of fumes and air-borne particles are removed. A potential of 13,000 volts on oppositely-charged plates traps particles down to 1/250,000th of an inch. The cleaned air is then returned to the room.

Unusually Large Rubber-lined Bushing

Probably a record for size, a rubber insulated "Rubberflex" bushing of unusual load-carrying capacity, consisting of a wall of rubber which separates yet holds together a shaft bearing and an outer steel shell, has been completed by *Bushings, Inc.*, Berkley, Mich. It is to insulate heavy equipment against shock, vibration and wear.

It can sustain a radial load of 10,000 lbs. while under a torsional oscillating movement of 3 deg. at 1800 cycles per min. The Rubberflex method permits the assembly of dissimilar members of virtually any size. In this instance the inner member, an oil grooved shaft bearing, is 36 in. long. The outer steel shell is 28 in. long, 5½ in. in diam. Assembly was simple and without costly tools.

Temperature Control of Coolants and Lubricants

Especially desirable for heavy cutting and high pressure grinding operations and designed for accurate and automatic temperature control of coolants and lubricants in machine processing is the Frostrode model 75-AC coolant cooler, made by *Frostrode Products*, 19003 John R. St., Detroit 3.

The machine operator selects the coolant temperature by simply setting a dial on the panel of the cooler. Even variations in room temperature are automatically compensated for by an integral differential thermostat.

A single steel tube evaporator coil construction provides uninterrupted flow and eliminates operating and maintenance troubles, with no plugging up of passages as in conventional coolers.

Conserve tin for Uncle Sam..

"600" Alloy contains no tin, but ... for the majority of bearing problems..

will prove Superior!

● 600 Bearing Alloy is approximately three times stronger than the best cast bearing bronze—*yet it contains no tin.* It develops a lower temperature under heavier loads and higher speeds than the bearing bronzes, and extreme pressure lubricants do not corrode it.

600 is the solution to many difficult bearing problems. It can be drawn or forged and readily fabricated in a great variety of sizes and shapes.

600 Bearing Metal has been successfully used for the past 14 years for:

Gears • Gear Blanks • Bushings • Bearing Pins • Connecting Rods • Worm Gears • Cams • Thrust Washers • Propeller-Shafts • Drive Shafts • Super-Charger Shafts • Truck Transmisions, etc., etc.

Primarily where a bearing is subjected to a reciprocating motion, reduction in weight is essential to keep vibration at a minimum and to assure maximum efficiency. Because 600 Metal is stronger per unit of weight, parts can be made of equal strength out of 600 Metal with a REDUCTION OF 10% TO 35% IN THE WEIGHT OF THE FINISHED PART.

Investigate this superlative bearing metal which contains no tin; thus conserving this critical metal for our war effort.

If you have a bearing problem or want more complete information, please write us

MUELLER BRASS CO.

PORT HURON, MICHIGAN

"FLASH-O-LENS"

can help you

MAKE ACCURATE METAL INSPECTIONS IN A HURRY!

Careful and accurate inspections of metal parts and castings is a routine requisite of war equipment production. To meet this need, Pike now offers you the new FLASH-O-LENS—*a good magnifying lens plus proper illumination*—all in one compact, portable unit!

For more exacting surface inspections, a portable microscope can be attached to the FLASH-O-LENS (as illustrated) supplying magnifications up to 40X.

FLASH-O-LENS is available in two models; one for illumination by standard size dry cells; the other by current from any AC or DC outlet . . . Either is of greatest value even in the darkest corner of the shop.

Send today for illustrated catalog.

E. W. PIKE & COMPANY

PIKE

Manufacturers — ELIZABETH, N. J.

Now A *WELDED Line of Furnaces

- Available in Stationary and Tilting Types
- For Crucibles or Metal Pots
- Oil, Gas or Coke Fired

For Melting

MAGNESIUM
BRASS
LEAD
ZINC
ALUMINUM
COPPER
IRON ALLOYS

Personal Experience of 40 Years

***The Welded Sheet Construction** of these new **"Superior-Supreme"** furnaces gives you the advantages of greater strength and durability combined with decreased weight and neater appearance.

Write for Specifications Folder

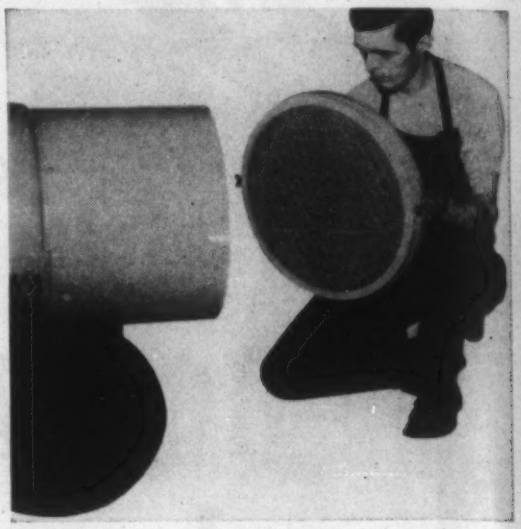
THE **HARVEY** FURNACE COMPANY

Manufacturers of Metal Melting Equipment, Ovens, Heat Treating Furnaces, Cupolas and Blowers

2935 St. Paul St., Baltimore, Md.

Filter for D.C. Welding Units

A long-lasting filter for d.c. generator welding units is announced by the *Badger Mfg. & Sales Co.*, 327 E. Brown St., Milwaukee, who claim that it doubles the



life of the generator and excitor brushes by taking all the damaging dust out of the air going into the welder.

Its life is from 4 to 5 years, and every time a Badger filter is cleaned, two throw-away filters must be replaced.

Carbide Tool Chip Breaker Grinder

A new carbide tool chip breaker grinder with greater flexibility and higher capacity has been brought out by *Carboloy Co., Inc.*, Detroit 32. It will grind breakers in single point tools and roller turner tools, and can be adapted to flat form tools and round or square boring bits.

Tools up to 2 in. wide can be handled. The long table has 10¾ in. of travel and there is no need to move the universal fixture on the table. Designed for 6 in. wheels, the head is vertically adjustable from either side of the machine. A base 29 in. high, has large storage space for tools, wheels, etc. The standard motor is single phase, 110 volts, 60 cycles, ¼ h.p. at 3450 r.p.m.

● *Vanadium Corp of America*, 420 Lexington Ave., New York, has officially designated its non-vanadium bearing type as Grainal No. 27. It will continue to designate the vanadium bearing types as Vanadium Grainal No. 1 and No. 6.

Hole Punch Units With New Adapters

Type B hole punching units with new adjustable adapters are announced by *Wales-Strippit Corp.*, N. Tonawanda, N. Y., for punching holes in flat sheets. The adapters are for mounting punching units on press brake rails, and they provide staggered and straight line hole punching patterns. Maximum front to back adjustment of these adapters is 3 in.

The punching units are designed for interchangeable use on press brake rails with adapters and T-slotted plates and templates in punch presses. Set-ups are made quickly by bolting the units to the plates and templates in the exact position determined by the master pattern.

Oxygen on the Warpath

THE warpaint of the Indian was clay, colored with brilliant rusts—the result of iron corroded by oxygen.

Oxygen is also the deadly foe of heat-treating . . . in which metals and alloys are heated at high temperatures to produce desired qualities. If only metals could be heat-treated in an atmosphere free from oxygen and its destructive companions, water vapor and carbon dioxide . . . this has been the metallurgist's dream!

Under the stimulus of war, this problem has been solved. The miracle begins with an energetic metal called LITHIUM, the lightest non-gaseous element known to science.

LITHIUM

An element so restless in its atomic nature that it searches ceaselessly for oxygen

LITHIUM is never satisfied until it unites with all oxidizing agents within its reach.

The Lithium Company has engineered LITHIUM and its magic vapor into its furnaces with results startling to both management and production. LITHIUM vapor fills the furnace . . . blankets the work . . . protects it until it is quenched. At no time can the work decarburize or oxidize.

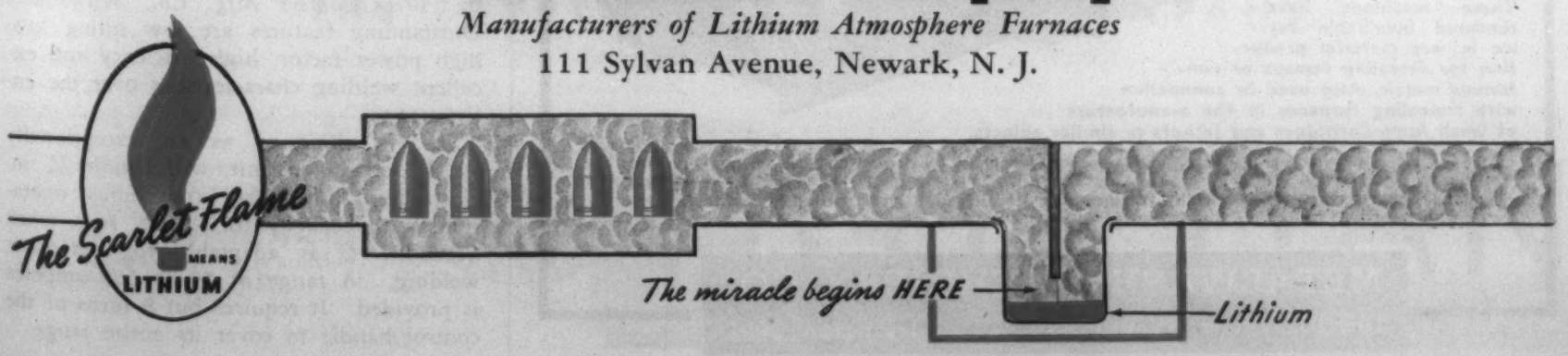
Management of key war plants have selected LITHIUM FURNACES, not entirely because of accelerated production and definite control of quality . . . but also with an eye on the economies needed to meet postwar competition.

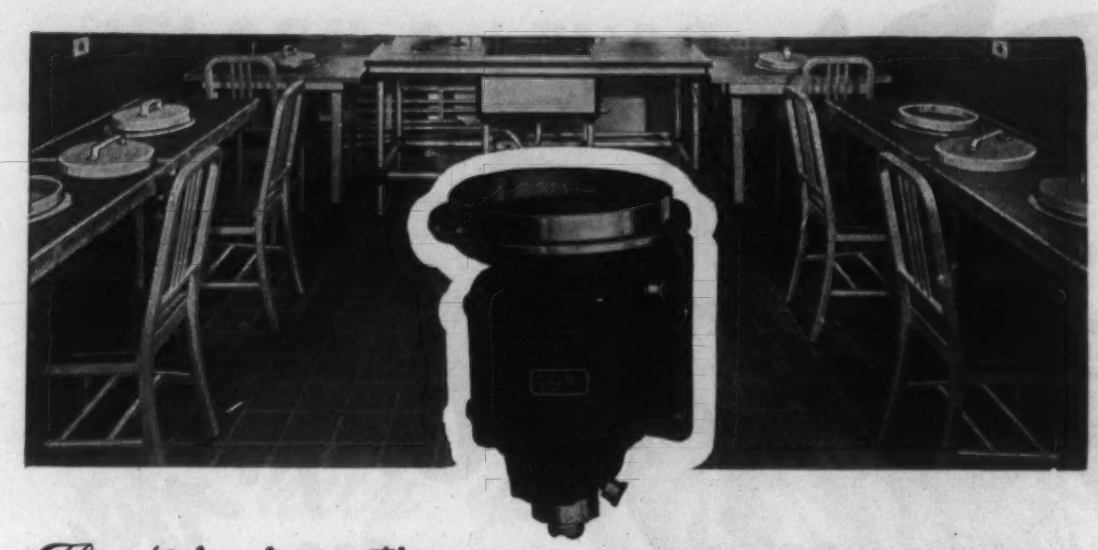
Planners for today and tomorrow will find the LITHCO story very interesting

The Lithium Company

Manufacturers of Lithium Atmosphere Furnaces

111 Sylvan Avenue, Newark, N. J.





The Cincinnati METALLOGRAPHIC POLISHING MACHINE
produces SCRATCH-FREE SPECIMENS EVERY TIME!

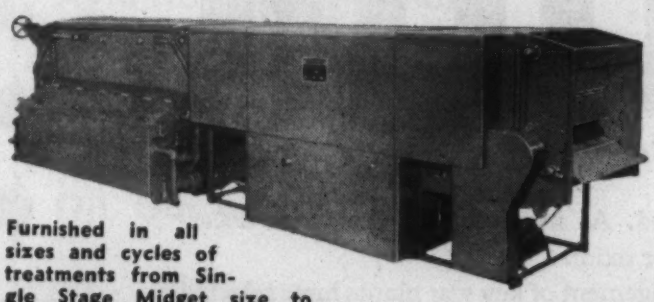
Features

- No belts, no friction drive — direct-connected.
- No excessive noise or vibration.
- Bronze bowl, disk and ring resist corrosion.
- No splashing of polishing materials.
- Ball bearing throughout.
- Easy to clean.

The Cincinnati Variable Speed Polishing Machine sets a new standard of efficiency for smoothness and simplicity of operation in the preparation of specimens for microscopic examination . . . uniformity and scratch-free surfaces are achieved consistently — even with inexperienced operators — because of the smooth running, direct connected, variable speed motor which gives a range of speeds between 300 and 3,000 R.P.M. Write for Bulletin S9 for full descriptive details.

THE CINCINNATI ELECTRICAL TOOL CO.
Cincinnati, Ohio

Metalwash Machines *for*
CLEANING :: DRYING :: PROCESSING
Cuts production time in war plants



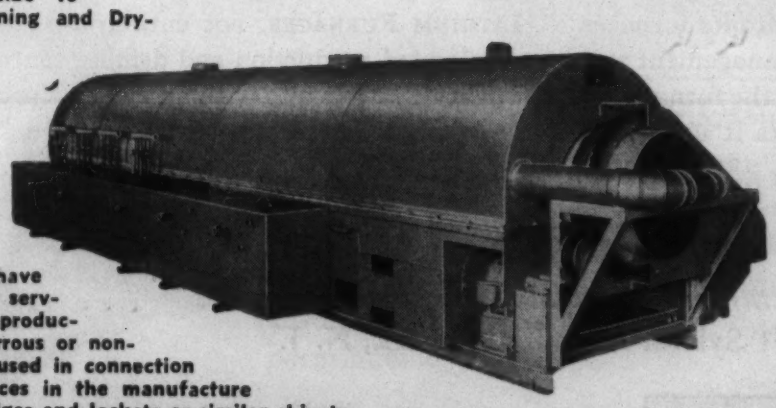
Furnished in all sizes and cycles of treatments from Single Stage Midget size to huge Industrial Cleaning and Drying Machines.

WASHING, RINSING DRYING MACHINE

Typical, medium sized sturdily built machine, objects may be placed directly on the conveyor.

Equally adaptable for cleaning small parts that are carried through in baskets.

REVOLVING DRUM PICKLING MACHINE



These machines have rendered invaluable service in war material production for descaling ferrous or non-ferrous metals. Also used in connection with annealing furnaces in the manufacture of Small Arms Cartridges and Jackets or similar objects.

This company, with nearly 20 years experience in designing and manufacturing Special Machinery and Equipment for Cleaning, Pickling, Drying and Rustproofing, invites you to consult with its Engineering Department concerning problems in the metal cleaning field. No obligation involved. Request our new MA folder.

METALWASH MACHINERY CO.
149-155 Shaw Avenue Irvington, N. J.

Sprayed-On Vitreous Coating

"Silco" is a new sprayed-on vitreous coating, which resists acids, mild alkalis, rust, corrosion, heat, impact, abrasion, etc., and is a dull finish that may be buffed to a beautiful egg-shell gloss. It is dried at 200 deg. F. and baked at 350 deg in a convection-type oven, or by infra-red lamps, and is produced in black, white, army drab and navy gray colors. It withstands heat up to 1000 deg. F., is not affected by a 200-hr. salt spray test, and is hard. It is not flexible, though will bend 30 deg. without breaking.

Silco has passed every specification issued by the Quartermaster Corps on May 4, 1943. The coating thickness is .001 to .002 in. Surface preparation is done either by sand blasting, or alkali cleaning, acid pickling, washing or bonding. A typical job is on gasoline engine exhaust manifolds, mufflers and pipes.

It is produced by the *Mitchell-Bradford Chemical Co.*, 2446 Main St., Bridgeport, Conn.

Cleaning Machines for Aircraft Engines

A new cabinet-type cleaning machine for aircraft engines that reduces manual operations to a minimum is announced by *Howard Engineering & Mfg. Co.*, 1028 Hulbert St., Cincinnati 14. Uniform and continuous cleaning is obtained by a turntable that holds the engine and its assembly stand as it comes off the production line. It revolves at 4 to 6 r.p.m. to produce complete wash, rinse and drying operations on one engine in 20 min.

Washing and rinse solutions are applied through one set of spray pipes that extend completely around the engine and its stand. Wash- then rinse-water are pumped on the engine parts, after which heated, high-velocity air is ejected through the blow-off nozzle.

● A new rivet gun kit to aid field service and repair men in heading up Cherry blind rivets is announced by *Cherry Rivet Co.*, 239 Winston St., Los Angeles. It has six interchangeable pulling heads for 1/8, 5/32 and 3/16 in. standard diameter rivets, one each for countersunk and brazier type head in all sizes. The kit contains a right angle adapter for inaccessible places.

New Sturdy Welder

A new "Ampac 400" welder, which uses the same basic electric circuit as the "Ampac 200" welder, has been brought out by *Allis-Chalmers Mfg. Co.*, Milwaukee. Outstanding features are low idling loss, high power factor, high efficiency and excellent welding characteristics over the entire range.

It was designed as an exceptionally sturdy self-cooled unit, will handle ¼ in. electrodes 24-hr.-a-day continuous operation, with capacity for ⅜ in. rods when needed. It is adaptable for automatic welding. A range of 50 to 500 amperes is provided. It requires but 8 turns of the control handle to cover its entire range.

"SPEC" COATINGS

Tailor-made to Fit Your Operation

Strict specification requirements don't crowd out the touch of genius that goes into all Egyptian "spec" finishes.

• AXS-736 REV 1 •

Take Egyptian's AXS-736 Rev 1 for cartridge cases, percussion primers and other steel surfaces . . . it's on the beam with the Ordnance Dept. and it fits your own set-up as though it were made to order for you. Extra hard, extra clear. Flexible in application. Dries for handling in 10 minutes. Bake at 350°F for half an hour, or 400°F for 20 minutes.

There's always a plus in an Egyptian Finish . . . for products of war or of peace.

★ ★ ★

Special correspondence on finishing problems is invited.

THE EGYPTIAN LACQUER MANUFACTURING COMPANY

ROCKEFELLER CENTER, NEW YORK 20, N. Y.

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Egyptian's new U. S. Government "Spec" Book—4th Edition—is ready. It's helpful and it's FREE. Send for your copy. Please address Dept. J-10

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EGYPTIAN FINISHES

EGYPTIAN

SUPERIOR FINISHES

News of Men, Societies, Meetings and Companies

Plants and Slants

A display centering around the model railroad was one of the most popular exhibits at an "Ordnance for Victory" show in Philadelphia recently. It depicted the tremendous job the carriers are doing in the movement of raw materials and finished products to their destinations in record time.

This particular exhibit was sponsored by the *American Car & Foundry Co.*, and was loaned by the *Chesapeake & Ohio.*

"If any one exhibit can be called the highlight of the show, it would be the model railroad you installed," wrote Col. D. N. Hauseman, Philadelphia Ordnance district chief, to Charles Hardy, president of *American Car.* "It is our outstanding attraction to young and old alike, and has certainly contributed materially to the success of 'Ordnance for Victory'."

The show in general showed weapons and equipment that American industry is producing, contrasted with some of the crude weapons captured from the Axis. Japanese hand grenades were merely "torpedoes" we used to throw on the sidewalk on July 4 by comparison with American-made products. Artillery wheels of Japanese cannon were often made like a patchwork quilt from scraps of iron.

German equipment is, of course, far superior to Japanese, but here many defects in welding are noted. Italian road mines were crude box-like affairs which soon clogged from rain and sand.

Our 105-mm. howitzer is superior in many ways to the corresponding 88-mm. German gun. It is more compact, sturdy, simple in parts and the gunners are not exposed as much.

It is evident, too, that Americans have the best supplies of raw materials with which to make munitions. All Axis countries, for instance, must skimp on copper. Japan in many instances shows the lack of sufficient steel.

Carnegie-Illinois Steel Corp. shattered all company records for steel production in August, turning out 1,962,631 tons of ingots, or 19,000 tons better than the previous record in March, 1943. The extra tonnage is enough steel for the hulls of four Victory cargo ships.

The honor roll of men in service from the plant of the *Lincoln Electric Co.*, Cleveland, consists of a steel plate on which are arc-welded their names.

A battery of 73 new coke ovens went into operation at the Indiana Harbor plant, *Inland Steel Co.*, on Aug. 26, with an estimated production of 1,000 tons daily. This is part of a project that involves two new blast furnaces and a second battery of coke ovens.

Daily war news broadcasts during lunch-hour periods prove singularly successful in bringing the workers of the Boston Navy Yard close to the battlefronts, the Navy's Industrial Incentive Div. reports. The broadcast is edited to show subtlely how important is each worker's job and how serious absenteeism is.

The *Carpenter Steel Co.* has appointed *Austin-Hastings Co., Inc.* as Eastern New England distributors for Carpenter tool steels, with warehouses located at Worcester and Cambridge, Mass., in addition to the one at Hartford, Conn.

Dr. Tracy C. Jarrett, chief metallurgist, Koppers Co., American Hammered Piston Ring Div., has concluded an agreement with the *Precision Scientific Co.*, 1736 N. Springfield Ave., Chicago, whereby they have acquired the sole rights to manufacture and market metallurgical apparatus originally developed by Dr. Jarrett and formerly marketed by himself. Dr. Jarrett is to be retained by Precision Scientific as consulting metallurgist collaborating with the company's engineering staff on a program of metallurgical apparatus developments. Such equipment now includes a specimen cutter, mounting press and specimen polisher, supplemented by essential accessories to prepare metallurgical specimens for microscopic examination. The Jarrett apparatus will be a nucleus for their expansion into the metallurgical field, which offers a new channel as manufacturer of scientific apparatus and production control laboratory equipment embracing over 2000 items.

Stuart's Thred Kut SOLVOL "Super-Kool" CODOL

Begin with the finest cutting Fluids...

THEN APPLY THEM PROPERLY . . .

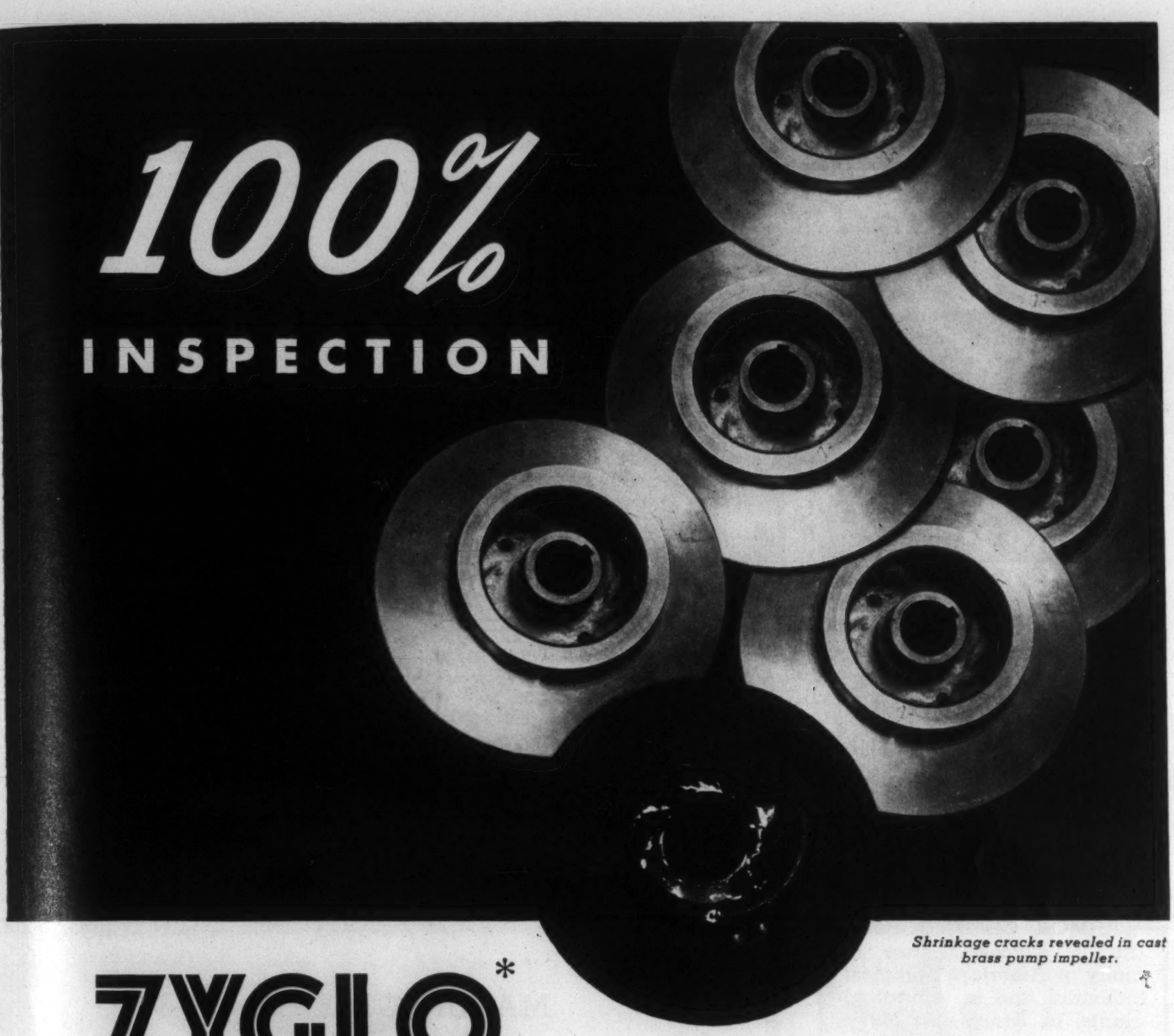
● Anything less than the best cutting fluids available is a handicap to your production. Equally important is *proper application.* Stuart Oil Products and Stuart Oil Engineering will give all the advantages it is possible to get from cutting fluids.

For All Cutting Fluid Problems

D. A. STUART OIL CO.

Chicago, U. S. A. • LIMITED • Est. 1865

Warehouses in Principal Metal Working Centers



Shrinkage cracks revealed in cast brass pump impeller.

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BLACK LIGHT METHOD Permits Pre-Inspection for Flaws of Every Part in Production

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News of Engineers

T. H. Wickenden has been made manager, Development & Research Div., International Nickel Co., with *H. J. French,* assistant manager. Mr. Wickenden, who has been assistant manager since 1931, succeeds the late Albion James Wadhams. He was in charge of engineering for Studebaker from 1913 to 1920, joining Nickel in 1922. He has made several inventions involving nickel in cast iron, and many of his engineering data sheets on that subject have been published in the technical press. Mr. French is now with the Steel Div., WPB, and previously was in charge of alloy steel development in International Nickel's Development & Research Div.

Dr. J. A. Neumann has been made president of the American Agile Corp., Cleveland, and will still retain his position as director of research, in which capacity he is well known as a lecturer and writer, with an unusually wide experience in welding.

Floyd H. Stroup has become metallurgical engineer with Ohio-Ferro Alloys Corp., Canton, Ohio. He was formerly with Central Steel Co. and Republic Steel Corp., Massillon, Ohio, on slag research; Timken Steel & Tube Co. as melt shop metallurgist; Copperweld Steel Co., as electric furnace superintendent; and Follansbee Steel Corp. as assistant open-hearth superintendent.

William J. Conley, former chairman, Engineering Dept., University of Rochester, has joined Lincoln Electric Co., Cleveland, as consulting engineer, handling problems on mechanical and structural design utilizing welding, as well as metallurgical problems of welding. Previously he was with the Gleason Works, Rochester, N. Y.

R. J. Minshall has been made president, McCulloch Engineering Corp., Milwaukee, maker of superchargers. He is also president and general manager of the Pump Engineering Service Corp., Cleveland. He has been awarded the Wright Brothers medal for his contributions to aeronautics. *James P. Stewart* has been named assistant general manager, having been assistant director of research, Elliott Co., Jeannette, Pa.

Col. C. H. Greenall, formerly of Bell Telephone Laboratories, has become director of the laboratory at Frankford Arsenal, Philadelphia, succeeding *Sam Tour,* who resigned.

C. A. Hartman has joined the metallurgical and engineering service staff of the Meehanite Metal Corp., Pershing Bldg., New Rochelle, N. Y. He was foundry superintendent of the Harrisburg Machine Corp., Harrisburg, Pa.

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Harry T. Worthington has become general manager of Beardsley & Peiper Co., Chicago, maker of foundry equipment, specializing in product development and sales organization and promotion. He was formerly a sales and production executive with Manning, Maxwell & Moore.

Elmer C. Cook and *Fred J. Schweizer* have formed the Cook-Schweizer Co., Elizabeth, N. J., to do commercial heat treating. They were formerly with the American Gas Furnace Co.

Walther Mathesius has been elected president and director of the new Geneva Steel Co., Geneva, Utah, which is expected to go into operation at the end of the year. He is vice president in charge of operations of U. S. Steel Corp. of Delaware.

George E. Whitlock, president of the newly-organized Pressed Metal Institute and president of Mullins Mfg. Corp., was the first civilian to receive official U. S. Army Ordnance citation for his contribution to the war effort.

Herluf Nielsen, Ph.D., has been appointed chief metallurgist in charge of the technical department at Kinney Aluminum Co., Los Angeles, producer of heat-treated aluminum and magnesium alloy castings. Previously he was director of physical metallurgy at Washington State College.

Briefs on Associations, Promotions, Education

The first meeting of the newly-organized Texas foundry group will be held at Houston, Oct. 29, where the guest speaker will be R. G. McElwee, Vanadium Corp. of America, Detroit, chairman of the cupola research project of A.F.A. and an outstanding metallurgist. The head of the organization committee is F. M. Wittlinger, Texas Electric Steel Co., Houston. This group may eventually become a Texas chapter of A.F.A.

An intensive part-time course in physical metallurgy is being offered at Columbia University, New York, to give a fundamental training to men and women now employed in metal and associated industries. High school graduation is essential and preferably some college training in chemistry and physics. Information on the course is obtainable from Room 313, Engineering Bldg., Columbia University.

A training center for arc welders, machinists and sheet metal workers has been acquired by the U. S. Maritime Commission at the training center of the National Youth Administration at Chester, Pa. It has work stations for 32 arc welding students, 23 machine shop students and 20 in sheet metal work. Similar N.Y.A. facilities in four other cities may also be taken over.

"Occurrence and Production of Vanadium," by George O. Argall, Jr., is a recent publication of the Colorado School of Mines, Golden, Colo. It comprises 56 pages, including a map showing the location of vanadium mining districts of the Colorado plateau region.

The eighth annual meeting of the Industrial Hygiene Foundation will be held at Mellon Institute, Pittsburgh, Nov. 10 and 11, the main purpose being to plan for healthful conditions in war plants.

Four American metallurgists will give lectures and laboratory help to Brazilian scientists and industrialists through the Escola Politecnia of the University of Sao Paulo. It is being financed in part by Nelson A. Rockefeller, and administered by Stevens Institute of Technology. Each American will reside in Brazil three months. The Americans will leave for Brazil in the following order: Dr. A. Allan Bates, manager Westinghouse chemical and metallurgical laboratories; Dr. Robert F. Mehl, head of metallurgical engineering, Carnegie Tech.; Prof. Arthur Phillips, Hammond Metallurgical Laboratory, Yale University; and Prof. Gregory J. Comstock, director of powder metallurgy laboratory, Stevens Institute.

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ranging from microscopic life to the planets has been printed for students at the Western Pennsylvania School for the Blind. The booklet was written by research experts of Westinghouse.

Evening graduate courses for engineers, season of 1943-44, have been announced by Stevens Institute of Technology, Hoboken, N. J. Thus, among courses in metallurgy are those on powder metallurgy, alloy steels, advanced metallographic laboratory, non-ferrous metals and production metallurgy.

The American Association of Industrial Editors, Ottumwa, Iowa, has elected as president Clayborn L. Jackson, editor of *Acme News,* house organ of Acme Steel Co., Chicago. The association includes editors of 90 of America's leading industrial organization papers.

A new sound movie, "2311," designed to spur war production, has been released by General Electric Co. The name "2311," represents the number of American casualties incurred during the last 24 hrs. before the Armistice of World War I. The film runs 11 minutes and may be obtained in 16- or 35-mm. size upon request to the Visual Instruction Sec., G.E., Schenectady, N. Y.

Meetings and Expositions

ELECTROCHEMICAL SOCIETY, annual convention. New York, N. Y. October 13-16. 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Regional meeting; Institute of Metals and Iron & Steel Divisions. Chicago, Ill. October 16-19, 1943.

AMERICAN SOCIETY FOR METALS, annual convention. Chicago, Ill. October 18-22, 1943.

AMERICAN WELDING SOCIETY, annual meeting. Chicago, Ill. October 18-22, 1943.

WIRE ASSOCIATION, annual convention. Chicago, Ill. October 18-22, 1943.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION, annual meeting. New York, N. Y. October 25-29, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, national fuels and lubricants meeting. Tulsa, Okla. November 4-5, 1943.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting. Pittsburgh, Pa. November 15-16, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting. New York, N. Y. November 29-December 3, 1943.

NATIONAL CHEMICAL EXPOSITION. New York, N. Y. December 6-11, 1943.

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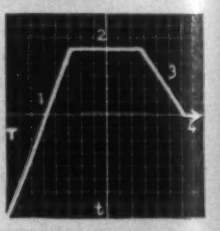

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trends

By Edwin F. Cone

Consumption of Magnesium

Possibly one-quarter of the total production of magnesium will be used in aircraft says P. D. Wilson of the WPB. "Other important requirements are for incendiary bombs, Signal Corps demands for aircraft and other equipment, and powder for tracer ammunition and flares. Exports to allied nations will be substantial."

Uranium

Because increasingly important war uses make it necessary to conserve supplies and stop relatively non-essential consumption, the WPB has prohibited the sale, delivery, purchase or receipt of uranium and its compounds for use in glass, pottery, tile and other ceramic products. It is used in ceramics as a coloring agent.

Plastics in a New Role

The almost universal practice of the various States has been to use as little metal as possible this year in the production of automobile license plates. One state, Illinois, has done away with metal completely, using a full-sized plate, front and back, made of one of the plastic materials.

Gain and Loss in Foundries

There has been a net loss of 10 foundries in the United States in the last 2 yrs. Penton's Foundry List for 1943-1944 shows that there are 4802 foundries in operation as against 4812 in 1941, when the previous edition was published. The number of gray iron foundries decreased from 3006 in 1941 to 2890 now. Steel foundries jumped from 298 to 334. Exclusive non-ferrous foundries increased from 1446 to 1506. A surprising trend is the decline in aluminum foundries to 2620 as against 2800 in 1941. The total number of magnesium foundries is 129 for 1943; they were not segregated in previous reports.

Use of Low-Grade Iron Ores

So serious is the drain on the high-grade iron ore reserves of the Lake Superior district, due to the present high rate of consumption, operators of those mines are looking for some practical method of utilizing the large supplies of low-grade hematites in that district. The cooperation of the Battelle Memorial Institute of Columbus, Ohio, in a research program has been arranged. The purpose is stated to develop means for utilizing the low-grade ores without which the steel industry will begin to feel the pinch of diminished reserves within 10 yrs. The main problem involved is the separation of silica from the iron oxide. An expenditure of $50,000 annually is contemplated.

Electrolytic Tin Plate

The application of electrolytic tin plating is expanding rapidly. By late July there were 26 electrolytic tin plate lines completed or under construction in the mills of 11 companies. The use of the electrolytic process constitutes a second major change in tin plate practice in a short time. Only a few years ago cold-rolled tin plate came into vogue and now the use of the electrolytic process is rapidly gaining favor.

Lake Iron Ore Ships

The carrying capacity of the American iron ore fleet in the Great Lakes has risen to a new high each month this year. At the close of 1942 this capacity was 2,803,090 gross tons per month; it is now (July) 2,889,090 tons. Two new vessels, the Cadillac and the Champlain, were recently added to the fleet, and others are on the way. A peak will be reached this fall when the last of 16 Maritime Commission ships sail.

Texas Pig Iron

Two blast furnaces are being constructed in Texas. When they go into operation during the fourth quarter, Texas will resume her place among the nation's pig iron producing states. The two stacks are — a 274,000-ton one for Sheffield Steel Corp., at Houston and a 432,000-ton stack for the Lone Star Steel Corp. at Daingerfield.

Beryllium

Expansion in the demand for beryllium in the last few years is characterized as remarkable. According to a report to WPB by the National Academy of Sciences, the consumption of beryllium ore in 1941 was about 2500 tons, and about 6000 tons will be available this year. In spite of this, the 1943 demand for beryllium will be 20 per cent more than the supply, and next year about 8000 tons of ore will be needed.

Less Stainless Steel

For the first time since 1938 the production of stainless steel declined in 1942. There was a progressive increase in total from 95,954 net tons in 1938 to 371,984 tons in 1941. The 1942 total was 340,780 tons.

There was an increase over 1941 in the output of 18 and 8 and of "all other high chromium or Cr-Ni alloys," with declines in the 12 to 14 and 16 to 18 per cent Cr types.